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EDITORIAL

WORSE THAN WAR

Have you ever been in Bridgeport, Connecticut? Or in Long Beach, California? Or in Paterson, New Jersey? Or in Des Moines, Salt Lake City, San Diego, Scranton, or Tulsa? If you have, you can imagine the shock that the people of the United States would experience if they learned that every man, woman, and child in any one of these big cities (which are of about the same size) had been killed by an earthquake, or by a hostile world-power with which we happened to be at war, or in any other unexpected way. Yet our automobiles are now dealing out death to that number of good citizens every five years, and the public does not appear to be very profoundly impressed by the circumstance. Why not? We can easily prevent this frightful slaughter, too. Why don't we do it? Why are we so complacent about it, when our automobiles are killing us off, even faster than the Great War did, during the eighteen months when its toll was heaviest?

In this connection, the following extract from an article written by Vice President R. J. Sullivan of The Travelers Insurance Company (and originally published in *The Journal of Commerce)* will be of special interest:

"During the past fifteen years, much has been done to make cars, streets and highways safer for drivers, riders, pedestrians, and property. Brakes, compared to those of 1915, are marvelous. The increased reliability of tires is a remarkable achievement. Steering gears, axles, and other important parts are reliable. The number

of traffic policemen, both vocal and silent, has been greatly increased. Stop-and-go lights protect thousands of dangerous intersections. Many, many miles of road have been widened, safely surfaced, and straightened. Dangerous grades have been removed.

"But—

"52,760 persons were killed in the five-year period ending with 1920,

"88,998 persons were killed in the five-year period ending with 1925,

"141,041 persons were killed in the five-year period ending with 1930.

"282,799 persons have been killed in the past fifteen years.

"Drivers Over-rate Safety Improvements

"Why is the record so bad in the face of such improvements? Merely because drivers have over-rated the efficacy of these improvements and their own ability to drive. They have increased their speed more rapidly than driving conditions have warranted. They have relied too much on things mechanical and have failed to accept as part of the privilege of operating an automobile that personal responsibility which should be a prerequisite of the privilege. Public policy demands that the authority to drive shall be limited to those who will recognize their responsibility to their passengers, the pedestrians, and other users of the highway, because driving is a privilege and not a right.

"The Public Must Be Aroused

"Nearly everyone who has made a study of causes of automobile accidents, or who has had any extended experience in compensation insurance, knows what important kind of safety work remains to be done, even though he may not know just how it should be done.

"The job is one of arousing the public to the seriousness of the situation, which threatens to get worse before it gets better, and then inculcating a proper appreciation of the personal responsibility which rests on both drivers and pedestrians (between 30 and 40 million of the 120 million people in the country are both)."

The Travelers Standard. The Travelers Insurance Co.

PRACTICAL USE OF THE ELECTRO-MOTIVE SERIES IN ELECTRO DEPOSITION AND SEPARATION OF METALS

By John J. Mulligan, Supt. U. S. S. Lead Refinery, Inc.

Read at Chicago Branch Annual Meeting, January, 1931

We have, as a theory, the electrochemical order of the elements and this order is taken advantage of in the electrolytic deposition of metals, or, in other words, we take advantage of this electrochemical order to dissolve specific metals in preference to other metals that may be alloyed in anodes, even in large or small quantities. Where we have a selective solution of one particular metal in a special electrolyte, leaving numerous other metals as an insoluble anode mud, it makes a simple problem for the refining or deposition of this particular metal.

In the ordinary daily practice of electroplating, pure anodes are not always obtainable, and the same applies to electroplating where pure salts are to be obtained, using the insoluble anode, with the consequence that we begin to run into trouble, due to the building up of the non-desired metals, which means, in some cases, additional power costs, additional replacements of new electrolyte, and, the worst of all, rejects of finished product.

Due to the solubility of the various metals in the solute, we have to consider the solubility demand of the system to be used. The system is at equilibrium when no reaction is possible without the interference of some chemical or physical outside agent. In this case increased temperature, pressure, or mechanical circulation, or the addition of a small quantity of the pure electrolyte, or some other salt, may overcome this condition.

This brief paper is simply to give you experienced men a thought as to how readily, or simply, a bad condition may be corrected at times.

In electrolytic refining of lead, with which I am quite familiar, we are quite fortunate in having electrolytes such as lead fluosilicate and hydrofluosilicic acid, which electrochemically dissolves only lead from impure anodes, which we use, leaving behind, as an insoluble mud, antimony, arsenic, and various other metals.

In the plating trade, if the operators can familiarize themselves with the impurities which cause them the most difficulty and increase costs, it behooves them to try some small scale tests in connection with regular operations and also take advantage of the electrochemical order of the elements and select a specification for anodes that will improve their operations. There are times when

anodes are purchased simply as anodes and 1% impurities, more or less, means nothing to the ordinary plater. This is all well and good if it happens to be one particular impurity, which has never caused any great amount of trouble, but the replacement of this one impurity, which has caused no trouble, by a small percentage of other impurities, may cause untold trouble after it has been used for long periods. Here is where the man in charge must do some real thinking and decide, after the electrolyte has been fouled, whether there should be a replacement of the electrolyte with new, or should they try some means of removing the impurities with the consequent saving of considerable money in regenerated electrolyte, or figure out if it would be cheaper to discard the bulk of the old electrolyte to be entirely replaced by new. From the operating standpoint, there are two real items to be considered, the quality of the product and the cost of the product. Too much theory should not be allowed to influence the steps taken to correct quality or costs. No doubt expensive chemical means would regenerate fouled or spent electrolyte, but time and labor might offset the replacement of this fouled electrolyte by new electrolyte.

Again reverting back to the electrochemical order of elements, there have been occasions when this theory has been the means of spoiling parts to be plated, where the cathodes had been immersed in the plating bath and allowed to stand too long a time before electrical current was applied. What I am getting at is the cementing out on some particular cathodes of the impurities that are in the electrolyte, but this could be prevented by making the electrical contact simultaneous with the immersion of the part in the electrolyte. Lead sulphate is insoluble in dilute sulphuric acid solutions, but in certain electrolytes of sulphuric acid, where iron and other impurities may have built up, due to use, we have a solubility of lead sulphate with the consequent deposition of some lead on the cathode and the resulting final product of not as high a purity as it is possible to obtain by the electrolytic method. The same holds good for other electrolytes and metals. I know this to be true in the electrolytic refining of copper, zinc, cadmium, from the sulphuric acid electrolytes. With insoluble anodes, there is always a higher voltage than where you have the soluble anode, with the supposition that your voltage becomes abnormally high, then the supposed chemically insoluble salts are dissolved electrochemically and some deposited on your cathodes.

There are certain combinations of metals which may be soluble in the electrolyte that are beneficial, especially from the electrical standpoint, which is particularly true of silver and copper in the electrolytic separation of gold and silver. From actual experience, we know that the presence of copper nitrate in the silver nitrate electrolyte greatly increases conductivity up to certain limits. We also know, from experience, that the addition of ammonium nitrate increases considerably the electrolytic conductivity of silver nitrate electrolyte and copper silver nitrate electrolytes, within certain limits also. It might be of interest to you to know that as high as 60 grams of copper and 60 grams of silver, using silver anodes of about 99% purity, allow the electrochemical refining of silver and give chemically pure products in return. Not going into the theory of this separation of silver from the silver copper nitrate electrolyte in the presence of such an amount of copper, is another evidence of what is to be learned in the electroplating field, relative to the presence of certain impurities, both in anodes and the electrolytes in daily use. The matter of the deposit in the refining of metals is more of a problem than in the case where there is just a thin deposit required, then we have to learn to appreciate the various effects of the many addition agents and wonder at the results we obtain for the very small quantities that we have to add to a large volume of electrolyte to obtain the desired deposit. In the case of the electrolytic deposition of lead, we are adding the equivalent of 1½ pounds of goulac, use patented (spent sulphite liquor from paper industry) per one ton of lead deposited electrolytically per day. This is also equivalent to about one one-hundredth of a percent figured against the weight of the electrolyte in the system for the deposition of the above-mentioned amount of lead. If you can appreciate, from this illustration, how small a quantity of a foreign substance is necessary to influence electrochemical action, it might be well to see if you can always put your finger on the cause of some of your troubles. What I am getting at is the idea of making you fellows find out whether your trouble is electrolytic, too much voltage, is it chemical, concentration of your solutions, your temperature, or some other condition over which you could have good control. We know that if we allow certain impurities, taking iron and aluminum as illustrations, and allow them to build up in electrolytes, the percentage may increase to such a point that we obtain these two elements in colloidal forms and this is a physical condition, which does not encourage better deposits for the trade.

The electrochemical order of the elements should always be considered where metal impurities build up in plating solutions. The part to be plated should be inspected for surface condition in the event that cementation of some other metal on it would influence quality of deposit. This reaction is due to the position of the metals concerned in respect to their position in the scale of the electrochemical order of the elements.

I have tried to give some practical applications and experiences that you operators may have thought of, and some have applied corrections where others have not. I appreciate this opportunity of meeting with your society, and hope that we have benefited by our meeting.

SUMMARY
CONFERENCE ON EXPOSURE TESTS OF PLATED COATINGS

Chicago, January 16, 1931

I. Introduction

At the invitation of the Research Committee and the Chicago Branch of the American Electroplaters' Society, a conference was held on January 16, 1931, to discuss the program for exposure tests of electroplated coatings. This program is to be carried out through the cooperation of the American Electroplaters' Society, American Society for Testing Materials, the Bureau of Standards, and interested manufacturers. Invitations to the conference were sent to the officers and Research Committee of the Electroplaters' Society; the advisory sub-committees of A.S.T.M. Committees A-5 and B-3, and to other persons who have expressed an interest in this program. About thirty-five persons were in attendance, as listed in the appendix to this report.

Two sessions of about three hours each were held. As the stenographic report occupies 170 typewritten pages, it was decided not to distribute it. Instead this summary has been prepared for publication and distribution. The stenographic report may be consulted by making application to H. A. Gilbertson (Secretary of the American Electroplaters' Society) or to W. Blum.

As the meeting was advisory and not executive, no formal actions were taken. In the following summary, prepared by the presiding officer, W. Blum, an effort has been made to present briefly the conclusions reached either through informal votes or through acquiescence. In general there was a full and frank discussion, and

it is believed that the principal conclusions were concurred in by most of those present. These recommendations are being incorporated, so far as feasible, into a revised program of tests which will be distributed for further comment before it is definitely adopted or published.

II. Events Preceding the Conference

Over a year ago the Research Committee of the American Electroplaters' Society adopted as the principal subject for study by their Research Associate at the Bureau of Standards the protective value of plated coatings, especially of chromium. Soon after this research was started, their Research Associate, W. P. Barrows, resigned, and the position was not filled till December 1, 1930, when P. W. C. Strausser was appointed. In the meantime arrangements had been made with the A.S.T.M. for the exposure in various locations of plated samples to be prepared in this study. A tentative program of such tests, all related to chromium coatings, was prepared and distributed for consideration at the Chicago conference. A joint inspection committee was previously appointed, with the following membership (revised in accordance with the appointment of the last three by the A. E. S. Executive and Research Committees on January 18, 1931):

W. Blum, Chairman, Bureau of Standards, Washington, D. C.;

F. A. Hull (Chairman of Sub-Committee VIII of A-5), General Electric Co., Schenectady, N. Y.;

W. M. Phillips, General Motors Corporation, Detroit, Mich.;

C. E. Mobius, Western Union Telegraph Co., 60 Hudson St., New York City;

J. Hay (Chairman of the Research Committee, A. E. S.), 6920 Ottawa Ave., Edison Park, Chicago, Ill.;

P. Sievering (Secretary of the Research Committee, A. E. S.), 20 South Crescent St., Maplewood, N. J.;

A. K. Graham, University of Pennsylvania, Philadelphia, Pa.

III. Principal Conclusions of Conference

1—*Purpose and Scope of Investigation:*

The two principal purposes of the investigation are (1) to determine the relative value for protection against corrosion of electroplated coatings of known composition, thickness and preparation, and (2) to determine the relation of laboratory tests on such coatings to their protective value under different conditions of service.

To accomplish these purposes, it is necessary that the corresponding specimens be uniform and reproducible, that the conditions of exposure be as definite and representative as climatic conditions permit, and that the samples for laboratory tests be prepared under the same conditions as those for exposure tests. No consideration was given to the details of the laboratory tests, which will be conducted after the exposure tests are started. It was pointed out that these tests might include (1) accelerated corrosion tests, (2) porosity tests, (3) stripping tests (for weight or distribution of coating), (4) adhesion tests (before and after exposure) and (5) exposure to corrosion while stressed.

2—Location of Exposure Tests:

From present plans the specimens will be exposed at the A.S.T.M. locations in Sandy Hook, Penna. State College, Pittsburgh and Key West; at the Bell Laboratories in New York, and at the Bureau of Standards in Washington. It was agreed that these included the principal types of severe atmospheric exposure. It was also suggested that if companies or organizations are conducting similar exposure tests in other locations, it might be feasible to include in such tests a small number of typical specimens plated in this investigation, in order to detect any marked differences in behavior with the location. This possibility will be carefully considered.

3—Order of Tests:

In view of the great importance of steel as a base metal, and of the present uncertainty regarding the relative protective value of different plated coatings on steel, it was decided to confine the initial tests to steel. In addition it was decided to expose simultaneously the steel samples plated with nickel, chromium, cadmium, zinc or copper, or their combinations. Experience has shown that comparable results can be expected in exposure tests only if the samples are exposed simultaneously. A variation in the initial climatic conditions might lead to widely different results. In order to investigate this point, a few exposures of auxiliary samples may be started at different intervals.

After the steel samples are exposed, specimens of brass, zinc, aluminum, etc., will be plated, and will be exposed at appropriate times. A year may elapse before this latter work can be undertaken.

4—*Solutions and Conditions to be Used in Plating:*

In general the purpose is not so much to learn the behavior of a metal under any specified conditions, as to determine the effects produced by changing those conditions in one or another way. To determine such effects with certainty it may be desirable to include conditions that are known to be outside of good working limits. Sometimes it is desirable to have some inferior deposits in order to learn what conditions are superior. It is not feasible, however, to include a wide variety of conditions, with every possible combination, as then the program would become prohibitively long and unwieldy. In general the effort will be made to employ conditions that represent good present practice, and then to change successively some one of those conditions, in order to determine whether such a change is beneficial or detrimental. The selection of any type of solution or operating condition as a basis of comparison involves no implication that such a solution or condition is necessarily superior.

For example, in the application of chromium an arbitrary set of conditions will be adopted as standard, and then variations will be made in the composition of the solution (both CrO_3 and SO_4), the temperature, current density, thickness of deposit, subsequent heat treatment, etc. With nickel the effects of changes in bath composition, pH temperature, and current density will be similarly studied. Both cyanide copper and acid copper deposits will be used in appropriate combinations. Deposits of zinc will be made from two acid and two alkaline baths. Cadmium will be deposited from at least two solutions, and zinc-cadmium alloys may also be used.

There was an extended discussion of the policy to be followed regarding patented or proprietary solutions. It was readily agreed that no secret or proprietary formulas should be included, and that all steps of the plating processes should be so fully described as to permit reproducibility by others. It was finally agreed that if for any reason it seems expedient to employ solutions or methods that have been described in the literature, but upon which patents may be claimed by one or more firms, reference shall be made in the reports to the journal articles, but not to any patents. This policy will avoid any occasion for an expression of opinion, direct or implied, regarding the scope or validity of any specified patents. The responsibility for pressing or acknowledging such claims will

then rest with the owners of the patents and the users of any process.

5—*Size, Shape and Arrangement of the Specimens:*

After considerable discussion, it was generally agreed that only flat metal plates should be used. The results from such specimens are likely to be more uniform and reliable than from complicated shapes, and will fairly represent the relative values of coatings of known, uniform thickness. It was fully recognized that the suitability of a particular plating solution for plating irregularly shaped articles may be largely determined by its throwing power, which factor will not be involved in plating the flat sheets. It was concluded, however, that the throwing power of a solution can be measured in laboratory tests, and can be confirmed by "spot" tests on articles of any given shape; and it is therefore not necessary to include this property as a variable in the exposure tests. To do so with even a small number of shapes would unduly extend the program, and would no doubt yield less reproducible results than can be obtained with flat specimens.

Suggestions as to the size of specimens varied widely. The use of small specimens may reduce the expense and space required, but the "edge effects" are likely to influence a greater proportion of the area than on somewhat larger specimens. It was then predicted (and has since been confirmed in experiments at the Bureau of Standards by P. W. C. Strausser) that after a few trials it should be possible to so space a number (for example, 1) flat specimens (for example, each 4″ x 6″) upon a rack in such a way that the plating will be nearly uniform on each specimen. It was concluded that fairly heavy gage steel, for example, 22 gage or 0.030″, should be used. Each specimen will be supported during plating, by means of a thin strip, partly cut away from one end. This strip may be stamped with an identification number and protected during exposure by a suitable lacquer. It was concluded that a plain carbon steel, for example, S.A.E. 1010, with about 0.1 per cent, will give representative results.

It was agreed that five specimens of each kind should be exposed in each location. For six locations this will require 30 exposure specimens, in addition to which at least 20 specimens will be made for subsequent laboratory tests. The complete program on steel will probably involve about 100 kinds of specimens, and will therefore involve the plating of at least 5000 specimens.

6—*Preparation for Plating:*

There was considerable discussion as to whether the surface of cold rolled steel (if necessary of special quality) would be suitable for plating without polishing; or whether one side at least of the steel should be given a high polish before any plating. It was fully recognized that the condition of the surface before plating may influence the porosity and value of the coatings. As, however, uniformity is a prime factor, it may be preferable to use a good cold rolled steel surface than an admittedly smoother, but possibly less uniform, surface produced by polishing. This question is still under consideration.

In any case certain of the intermediate or final layers may be buffed in order to determine the effects of such treatments.

The cleaning and pickling before plating will be done by usual simple methods, with enough variations to determine whether marked effects are thereby produced.

7—*Conditions of Exposure:*

It was concluded that in each location the specimens should be mounted at 30° from horizontal on racks running north and south. The specimens will therefore face east or west. If feasible, it seems desirable to have the supporting strips made of steel, galvanized or painted. The specimens will be supported by porcelain knobs, so that they will not come in contact with any other metal. While the exact program was not decided upon, it appears tentatively that in each location three racks, each representing a ground space of about 6′ by 12′, will be required.

8—*Methods of Inspection:*

The samples will be examined by members of the inspection committee at appropriate intervals, for example, every three months. The inspection must be principally visual, as loss-in-weight measurements will not bear any necessary relation to the corrosion of steel plated with nickel or chromium (though they may with zinc or cadmium). It was suggested that a plan similar to that proposed by E. M. Baker might be used. At each inspection each specimen would be given a quality rating, for example, 1, 2, 3, 4, or 5. Then in the final evaluation, each rating would be multiplied by the number of months during which it prevailed. The lowest total rating for a given period of exposure would represent the best quality.

The practical difficulty in applying this plan is to eliminate the personal equation of each inspector. It was suggested that (a) photographs be taken of representative coatings after exposure, (b) miscellaneous samples be collected in advance to represent types of corrosion, and preserved as "standards," or (c) such "standard" corrosion samples might be prepared in accelerated tests. Objections were made to each plan, and it appears that the inspection committee must be guided by circumstances, and must make copious notes and frequent inter-comparisons of ratings in order to insure consistency in their conclusions.

One important question is the extent to which the specimens should be cleaned at the time of inspection. Obviously, if the accumulations are the result of corrosion, they should remain, as they might influence subsequent corrosion. If, however, the specimens are so coated with dust, soot, etc., as to be obscured, some cleaning may be needed to determine whether corrosion has occurred. It was tentatively agreed that at each inspection one-half (divided vertically) of each specimen should be scrubbed with a bristle brush and water, and the other half not scrubbed. Here again the inspection committee must be guided by developments. In any case only the upper, exposed side of each specimen will be inspected.

IV. Cost and Support of the Investigation

In the absence of complete and detailed plans for this research, it was obviously impossible to make any exact cost estimates. A very rough calculation, however, shows that the total cost during the first year is likely to be at least $10,000, made up approximately as follows:

1—Research Fund—American Electroplaters' Society—		
Salary and Traveling Expenses of Research Associate	$4000.00	
Traveling Expenses for members of Inspection Committee	1000.00	
		$5000.00
2—Bureau of Standards—		
Salary of Junior Chemist	$2000.00	
Part time and Traveling Expenses of W. Blum	1500.00	
Special Equipment	500.00	
		4000.00

3—Manufacturers—

Steel, Anodes, Chemicals, etc. $1000.00

$1000.00

In addition the A.S.T.M. will furnish space and the use of any racks that are available, and A.S.T.M. members of the inspection committee will have considerable expense for travel.

P. Sievering, Treasurer of the Research Committee of the American Electroplaters' Society, reported that at present there is only about $3500 in the research fund, and that owing to present business conditions not many subscriptions have been received lately. Efforts are now being made to obtain subscriptions of at least $50 per year for three years from a sufficient number of firms to yield a fund of at least $5000 a year. The importance of this research to all firms interested in or engaged in plating is sufficient to warrant such support.

It is hoped that the principal materials required will be furnished without charge by about six manufacturers, several of whom have already indicated their desire to assist in this way. The detailed requirements will be taken up with the appropriate firms.

The revised program has been prepared and will shortly be circulated for comment. As soon as it is settled as definitely as is possible in advance, the specimens will be prepared, and will then be exposed in the various locations. In carrying out this program the inspection committee listed earlier in this report will be considered as an executive committee to decide questions that may arise during the investigation. In so doing, they will depend upon and feel free to call upon other members of the A.E.S. or A.S.T.M. for advice and cooperation.

V. List of Those Present at Conference

Barrows, Walter S., Canada Cycle & Motor Co., Weston, Ontario, Can.; Blum, W., Bureau of Standards, Washington, D. C.; Brown, M., Western Electric Co., Hawthorne Station, Chicago, Ill.

Coyle, T. G., United Chromium, Inc., Detroit, Mich.

Dubpernell, G., Udylite Process Co., 3220 Bellevue Ave., Detroit, Mich.

Farnsworth, F. F., Bell Telephone Laboratories, 463 West St., New York City; Fosburg, H. A., The Meaker Co., 1615 S. 55th Ave., Chicago, Ill.

Gehling, George, 5001 Tulip Street, Philadelphia, Pa.; Gilbertson, H. A., 434 South Wabash Ave., Chicago, Ill.

Hedden, S. E., Enameled Metals Co., 61 Bridge St., Etna (Pittsburgh), Pa.; Hopkins, L. W., Page Steel & Wire Co., Bridgeport, Conn.; Hippensteel, C. L., Bell Telephone Laboratories, 463 West St., New York City.

Liscomb, Fred, 6066 Nickerson Ave., Chicago, Ill.; Lopez, R. P., 72 Wilbur Street, Rochester, N. Y.; Lukens, Hiram S., University of Pennsylvania, Philadelphia, Pa.

Maucher, W. L. (representing F. A. Hull), General Electric Co., Schenectady, N. Y.; McGar, Benj. H., Chase Brass & Copper Co., Waterbury, Conn.; Meyers, Robert, 5231 School Street, Chicago, Ill.

Nissen, Wm. C., Roessler & Hasslacher Chem. Co., 230 E. Ohio St., Chicago, Ill.; Nixon, C. F., Ternstedt Manufacturing Co., Detroit, Mich.

O'Connor, R. J., Contract Plating Co., Bridgeport, Conn.; Oplinger, F. F., Roessler & Hasslacher Chem. Co., Perth Amboy, N. J.

Phillips, W. M., General Motors Corporation, Detroit, Mich.; Proctor, Charles H., Roessler & Hasslacher Chem. Co., 10 E. 40th St., New York City.

Rembard, C. E., New Jersey Zinc Company, Palmerton, Pa.; Romanoff, F. P., Apollo Metal Works, LaSalle, Illinois.

Schramm, George N., American Sheet & Tin Plate Co., Pittsburgh, Pa. (representing E. S. Taylerson); Servis, Oscar E., Felt & Tarrant Mfg. Co., Chicago, Ill.; Sievering, Philip, Philip Sievering, Inc., New York City; Smith, H. E., New York Central Lines, 466 Lexington Ave., New York; Smith, Horace H., 208 North 3rd Street, Newark, N. J.; Strausser, Paul W. C., Bureau of Standards, Washington, D. C.; Straw, W. A., Western Electric Company (representing T. S. Fuller, A.S.T.M. Committee B-3).

Westbrook, Leon R., Grasselli Chem. Co., Experimental Laboratory, Cleveland, Ohio; Wittig, Dan, Wittig & Gehrke, Job Platers De Lux, Milwaukee, Wis.

Zadowski, N. C., Peck, Stow & Wilcox Co., 2176 W. 3rd Street, Cleveland, Ohio.

SUMMARY
CONFERENCE ON ELECTROPLATING STANDARDS
Chicago, January 17, 1931

I. Introduction

At the invitation of the Chicago Branch and the Research Committee of the American Electroplaters' Society, a conference was held on January 17, 1931, to discuss standards and specifications of interest to the electroplating industry. About 50 persons were in attendance, as listed in the appendix to this report.

In the following summary, prepared from the stenographic report by the presiding officer, W. Blum, the conclusions represent the consensus of opinion and not the results of formal votes. No attempt was made to discuss details of any specification with a view toward action at that time. Such specifications as were considered were simply illustrative of principles to be followed in the subsequent work of appropriate sub-committees. At the meeting of the Research and Executive Committees of the American Electroplaters' Society on January 18, C. F. Nixon, Ternstedt Mfg. Co., Detroit, Michigan, was appointed chairman of a sub-committee on the preparation of specifications for materials used in plating; and H. S. Lukens, University of Pennsylvania, Philadelphia, Pa., chairman of a sub-committee on plated products. These chairmen will select their own committees, which will, in cooperation with other interested organizations, prepare tentative specifications. These will be submitted to the American Electroplaters' Society and other organizations for comment and adoption. All suggestions regarding such specifications should be sent to the above persons.

The conference considered both materials used in plating and plated products.

II. Materials Used in Plating

It was agreed that specifications for any such material should include a statement of the minimum acceptable content of the desired constituent, and of the maximum contents of impurities known to be detrimental. It will then be unnecessary to refer to harmless constituents, the maximum contents of which are automatically fixed by the other two definitions. For example, if chromic acid contains not less than 99.5 per cent of CrO_3, and not more than 0.2 per cent of sulphate (SO_4) or 0.2 per cent of insoluble matter, it is immaterial whether small amounts of water, alkalis, trivalent chromium, or other harmless impurities are

present. Of course, for any given material it is necessary to determine, by experience or research, whether certain impurities are detrimental, and to prepare the specifications accordingly.

Whenever the requirements for electroplating can be readily met by materials manufactured in large quantities for other industries, a separate specification is undesirable, as it restricts the sources of supply and may materially increase the cost. For example, it was felt that the Federal Specification (O-S-591) for sodium cyanide for use in fumigation will probably meet plating requirements. This specification requires that the salt contain not less than 51 per cent of cyanogen (CN), equivalent to 96 per cent of sodium cyanide (NaCN); and not more than 0.5 per cent sodium chloride (NaCl); that it be practically free from iron and that the residue after treatment with sulphuric acid should be completely soluble in water. In the discussion it was fully realized that further research might show that at least for certain plating purposes a more rigid specification might be needed, but that at present this appears adequate.

It was felt that no special specifications are needed for the regular acids and alkalis used in the plating industry.

A Federal Specification (O-S-61) for nickel sulphate, nickel ammonium sulphate and nickel chloride for use in electroplating and electrotyping was discussed as an illustration, and it was felt that this is satisfactory to both the manufacturers and users. In this discussion it was pointed out that when the water of crystallization in a salt is variable (as in nickel sulphate) it may be necessary to specify a minimum content of nickel, although this is in itself no evidence of purity. The latter must be insured by the limitation of harmful constituents, which must be directly determined.

In the discussion of anodes for plating, it was pointed out that whenever feasible it is desirable for these to correspond in purity to regular commercial grades of metal. This principle is probably applicable to copper, zinc, lead and tin anodes.

Consideration of nickel anodes showed that it is feasible to specify the composition of such anodes. For example, a 99+ per cent nickel anode might be defined as having not less than 99 per cent of nickel (+ cobalt) and not more than 0.05 per cent S, 0.10 per cent Cu, or 0.35 per cent Fe. As carbon, oxygen, manganese, silicon, magnesium and other elements are sometimes added to improve the behavior of the anodes, there is no occasion to limit their contents, except as the above specification does so auto-

matically. Of course, such a specification is subject to revision if other substances that are found in the anodes prove to be detrimental.

The discussion showed that there is a great difference in behavior of nickel anodes having the same purity, but prepared by different methods. In some cases the performance of the anodes is also governed by the composition of the solutions and conditions of operation. No definite conclusions were reached regarding a method of specifying the performance of a nickel anode. In any case it was agreed that the appearance of the anode is not itself important, and that the behavior of the anode is significant only in so far as it affects the character of the deposits, the care required to maintain the solutions in satisfactory operating condition, or the voltage required to produce a desired current density.

III. Electroplated Products

It was agreed that satisfactory specifications for plated products are valuable both to the manufacturer and consumer. The present competition with alloy steels emphasizes the need for such standards for electroplated coatings. Any general specifications must be prepared with respect to certain types of use or service; and then adapted or modified by mutual agreement, for any specified articles.

Any such specification may include (1) one or more requirements, (2) methods of testing to determine whether the requirements are met, and (3) information regarding means of meeting the requirements. For example, a specification for nickel plating on plumbing fixtures might include (1) a minimum average thickness of nickel, (2) the method by which this thickness shall be measured or computed, and (3) the approximate number of ampere-hours (or ampere-minutes) per square foot required to produce this average thickness. In such a case (3) is advisory, and compliance with it does not supersede the requirement in (1).

Among the possible requirements, one or more of which might be included in the specification of a plated coating for certain service, are:

1—A minimum average thickness, as determined by stripping tests. This may be expressed as weight of coating per unit area, or on small articles, as weight of coating per piece. Owing to the difficulty of sampling plated products, and to inevitable variations in plating, it is desirable to include a tolerance on individual samples and a smaller tolerance on the average of a number. For example,

in Federal Specification 411, for silver-plated ware, a minus tolerance of 15 per cent is allowed on individual pieces, and of 5 per cent on the average of three or more. Sometimes it is hard to meet even this requirement commercially.

2—A minimum thickness either on any part of the article or on any specified part such as the exterior of the bowl of a silver-plated spoon. This may be determined by a spot test or by microscopic examination. (The Preece test for zinc coatings is used by many as a minimum thickness test.)

3—A minimum porosity as measured by an appropriate re-agent, as in the ferroxyl test. However, it may be hard to define the degree of porosity.

4—A minimum resistance to corrosion, when exposed to an accelerated test such as the salt spray. Such a test is of value only if it is known that the results have some fairly definite relation to the behavior under the probable conditions of use.

5—A minimum resistance to abrasion. More work is required to determine the relation between such measurements as scratch hardness and actual wear under typical conditions.

6—A minimum adhesion. Bending tests are hard to apply and to interpret. The Erichsen test may sometimes be applied to measure adhesion of coatings on sheet metal. The Brinell test may be helpful on cast metals. Electrolytic cleaning or pickling or subsequent chromium plating may result in the detachment of poorly adherent coatings. Such methods might be standardized for use in testing adhesion.

7—Specified color and luster. It is sometimes found difficult to produce a desired color and luster, e.g., of gold, chromium and cadmium coatings. Apparently such a requirement must at present be based on the matching of prepared samples.

L. W. Hopkins read a report which was recently made by a special committee to Sub-Committee VII of Committee A-5 of the A.S.T.M. upon the need for specifications for plated products. A questionnaire was distributed to 127 persons, from whom 82 replies were received. In about half the replies, the adoption of some specifications for metals plated with chromium, nickel, cadmium, copper, or zinc was recommended. It is evident that the desire for such specifications is quite general, and that it may well be crystallized through cooperation of the American Electroplaters' Society, A.S.T.M. and other interested organizations. A large number of

societies now have specifications for zinc coatings on steel, some of which include zinc plated products.

As indicated in the introduction to this report, it is hoped that the work of the sub-committees of the Electroplaters' Society will promote the preparation and general adoption of suitable standards for both plating materials and plated products.

IV. List of Those Present at the Conference

Actis, Louis, Apollo Metal Works, La Salle, Ill.; Allen, Walter J., Crown Rheostat & Supply Co., Grand Rapids, Mich.

Barrows, Walter S., Canada Cycle & Motor Co., Weston, Ontario, Can.; Brown, H. E., Apollo Metal Works, La Salle, Ill.; Brown, M., Western Electric Co., Hawthorne Sta., Chicago, Ill.

Clindinin, C. E., General Spring & Bumper Corp., Chicago, Ill.; Corbin, Milford H., Ault & Wiborg Varnish Works; Coyle, T. G., United Chromium, Inc., 3220 Bellevue Ave., Detroit, Mich.

Danz, Martin, Western Clock Co., Peru, Illinois; Davies, L. A., Udylite Process Company, Detroit, Mich.; Delevitt, H. E., Keystone Plating Works, 4329 W. Kinzie St., Chicago, Ill.; Dubpernell, G., Udylite Process Co., Detroit, Michigan.

Faint, Harold W., U. S. S. Lead Refinery, East Chicago, Ind.; Farnsworth, F. F., Bell Telephone Laboratories, Inc., 463 West St., New York City; Fraser, O. B. J., International Nickel Co., Bayonne, N. J.

Gilbertson, H. A., 434 S. Wabash Ave., Chicago, Ill.

Hanlon, F. J., Chicago City Plating Co., Chicago, Ill.; Hedden, S. E., Aspinwall, Penna.; Hoefer, J. H., Crown Rheostat & Supply Co., Chicago, Ill.; Hopkins, L. W., Page Steel & Wire Co., Bridgeport, Conn.; Hunter, N. P., Egyptian Lacquer Manufacturing Co.

Liscomb, Fred J., 6066 Nickerson Ave., Chicago, Ill.; Lopez, R. P., Hickok Manufacturing Co., Rochester, N. Y.; Lukens, Hiram S., University of Pennsylvania, Philadelphia, Pa.

Kocour, C., The Kocour Co., Chicago, Ill.; Kennedy, Wm. J. R., 90 Maynard St., Springfield, Mass.

McMahon, R. D., Standard Steel Spring Co., Coraopolis, Pa.; Mesle, F. C., Oneida Community, Ltd., Sherrill, N. Y.; Meyers, Robert, Alemite Mfg. Corp., 2650 N. Crawford Ave., Chicago.

O'Connor, R. J., Contract Plating Co., Bridgeport, Conn.; Oplinger, F. F., Roessler & Hasslacher Chem. Co., Perth Amboy, N. J.

Phillips, W. M., General Motors Corporation, Detroit, Michigan; Pitschner, K., Firestone Steel Products Co., Akron, Ohio; Proctor, Charles H., Roessler & Hasslacher Chem. Co., 10 East 40th St., New York City.

Romanoff, F. P., Apollo Metal Works, La Salle, Ill.

Savage, P. M., The McGean Chemical Co., Cleveland, Ohio; Schuessler, H. O., Apollo Metal Works, La Salle, Ill.; Simpson, D. H., Edison General Electric Appliance Co., 5600 W. Taylor St., Chicago, Ill.; Smith, H. E., New York Central Lines, 466 Lexington Ave., New York; Smith, Horace H., 208 N. 3rd Street, Newark, N. J.; Soderberg, Gustaf, Udylite Process Co., Detroit, Mich.; Stadel, W. E., Wolverine Bumper Co., 415 Oakdale St., S.E., Grand Rapids, Mich.; Steuernagel, Robert, 1508 Concordia Ave., S. K. Williams Co., Milwaukee, Wis.; Stockton, F., Standard Steel Spring Co., Coraopolis, Pa.; Stoll, George E., Bendix Brake Co., South Bend, Ind.; Strausser, Paul W. C., Bureau of Standards, Washington, D. C.

Terrill, C. A., The J. B. Ford Sales Co., 1434 First Wisconsin National Bank Building, Milwaukee, Wis.; Torney, Austin E., Chicago Platers' Association, 38 South Dearborn St., Chicago, Ill.; Trapp, Samuel, Crest Lamp Company, Chicago, Ill.

Vande Bogart, L. C., Crane Company, Chicago, Ill.

Walsh, J. J.; Watts, O. P., University of Wisconsin, Madison, Wis.; Weinwuxer, W. H., Automatic Electric Company; Werlik, John, Business Agent, Metal Polishers' Union, Chicago, Ill.; Westbrook, Leon R., Grasselli Chemical Co., Expt. Laboratory, Cleveland, Ohio; Wilson Chase, C., Meaker Company, 1615 S. 55th St., Cicero, Ill.; Wittig, Dan, Wittig & Gehrke Job Platers, 1221 North 3rd St., Milwaukee, Wis.; Woelfel, E. A., Western Clock Company, La Salle, Ill.

Zadowski, N. C., Peck, Stow & Wilcox Co., Cleveland, Ohio.

INCREASING THE EFFICIENCY OF COMMERCIAL METAL POLISHING

By Edwin M. Baker

Associate Professor of Chemical Engineering—University of Michigan and

By George E. Holbrook

Department of Chemical Engineering—University of Michigan

Presented to Baltimore-Washington Branch, January 31, 1931

About 1925 we first became interested in reducing the cost of polishing and set about learning more about the operation. We

collected some of the material found in the dust collectors and on the floor near the automatic polishing machine and the hand jacks. Aside from miscellaneous dirt, this was found to contain about 50% of fine steel and iron oxide, with about 50% of polishing grain. Some of this grain was recovered and a screen analysis was made of it. To our surprise we found that there were coarser pieces in this recovered grain than in any grain that we were supposed to be buying at this time. A screen analysis was then made of the grain which we were purchasing. We then found that if the grain were recovered from the floor near a hand jack using, for example, No. 46 grain, this recovered grain had about the same screen analysis as the No. 46 grain which we were purchasing. From this it followed that most of the grain was leaving the wheels by simply being knocked off. It was not being lost by the grain being broken down into small particles, and being worn from the surface of the wheels by such a mechanism.

In order to cut down the usage of polishing grain per square foot of surface polished, it was evident that we had two means at our disposal. One of those was to recover the grain after it was lost from the wheel. The other was to so improve the wheel set-up and the polishing operation that the grain would not be lost from the wheel until it had done more work. The latter is obviously the logical solution. In order to determine what steps were necessary to prevent this loss of grain, it was, however, most important to know more about the polishing operation. For this purpose we set up a small experimental polishing machine.

The machine was designed to permit polishing under closely controlled conditions. It consists essentially of a shaft driven at a speed of 5900 r.p.m. Mounted on the end of the shaft is a polishing wheel approximately five inches in diameter by one-fourth inch wide. The peripheral speed of the polishing wheel is 7000 feet per minute. The steel to be polished is supported on an arm which is given an oscillating motion so that the steel will be moved under the polishing wheel. The movable arm is held up to the polishing wheel by means of a rubber balloon or football bladder supported on a scales and arranged to show the pressure on the wheel at all times. Distinction is, of course, made between the gross weight on the scales and the net weight, which is the pressure between the polishing wheel and the steel on which it is working.

The data obtained in the course of these studies led to the following conclusions:

(1) On coarse grain (i.e. No. 46 grain).

(a) Doubling the pressure between the steel being polished and the wheel will approximately double the quantity of steel polished away per minute.

(b) Doubling the pressure will approximately quadruple the wheel wear per square foot of steel polished, e.g. one-fourth as many pieces would be polished per wheel.

(2) On fine grain (i.e. No. 150 grain).

(a) Increase of pressure above 2.5 lbs. per inch width of wheel has little effect on the quantity of steel cut away per minute. (For pressures below this, the effect is much the same as for coarse grains.)

(b) Increase of pressure only slightly increases wheel wear per square foot of steel polished, or only slightly cuts down the number of pieces polished per wheel.

(3) Wheel wear is decreased, and therefore wheel life or efficiency is increased for the coarse sizes, i.e. No. 46 to No. 100, by applying a light coat of 25% by weight glue solution to the surface of the wheel about an hour after it is set up. No benefit is gained by this procedure on finer grains, and, in fact, the wheel efficiency may be thereby increased.

(4) Closely or accurately sized grain will polish or cut away about the same quantity of steel per minute as loosely sized grain. However, closely sized grain is much more efficient, and in the experimental apparatus as much as two and one-half times as much steel was polished away per pound of closely sized grain as could be polished with the loosely sized grain used in the experiments.

(5) A study of wheels as they are worn down confirms the usual observation that the speed of cutting decreases with wheel wear. No definite conclusion can be drawn regarding the change of wheel efficiency with wheel life. However, the use of stronger glue solutions in setting up the wheels is more favorable to maintenance of wheel efficiency than is the use of more dilute glue solutions.

(6) Different brands of grain and glue may give measurable differences in wheel efficiency.

Study of Plant Practice

Polishing Glue. With the above facts in mind, we turned our attention to plant practice. It was at once apparent that we must know more about glue used for setting up polishing wheels.

Among the characteristics of polishing glue which determine its performance are:

1. Viscosity
2. Jelly Strength
3. Grease
4. Foam
5. pH

Grease, foam, and pH are readily checked. Usually no trouble will arise with a good grade of glue because of difficulty with these three factors. The jelly strength is important, but is difficult to check without very special equipment, particularly without elaborate means for keeping the sample of glue at a constant temperature of 10° C ± 0.1° C (500 F.). The viscosity of glue is also very important, and it was found that if glue is abused in its preparation, the viscosity changes more rapidly than jelly strength. We, therefore, decided to use the viscosity at a given concentration as a measure of the preparation of this glue for use. There are a number of ways in which the viscosity of a solution like glue may be determined.

The glue solutions used for setting up polishing wheels are too concentrated, and their viscosity is too great to permit the ready use of the apparatus employed by the National Association of Glue Manufacturers. The apparatus used in the General Spring Bumper Corporation's plants is shown in Figure I. In its essential parts, it consists of a tube which is immersed in a constant temperature bath. A capillary tube inserted in the first tube permits the liberating of air bubbles at the bottom of

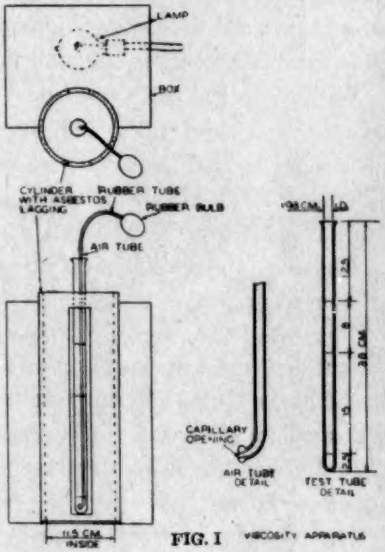

FIG. I VISCOSITY APPARATUS

the tube. The time required for air bubbles of a given size (approximately ¼ inch long) to rise between the two marks on the tube is determined by means of the stop watch. A very large number of readings can be taken in a very short time, and the average of ten readings, which are substantially checks, is taken as a measure of the viscosity of the solution.

Any method like this can be used to determine glue viscosity. In regulating the viscosity of glue in a plant, a sample of glue would be taken from a glue pot as the men are setting up wheels. The gravity of the solution would be determined at a standard temperature, and by reference to previously prepared charts, the concentration of the glue can be found when the gravity is known. The viscosity of the glue would then be determined and compared with the viscosity that should be developed in properly prepared glue of the same concentration.

Some of the results which were obtained when this method of testing was first employed showed that a glue which has been kept over night, or which has been overheated, has very poor viscosity, and would necessarily give poor results when used on a polishing wheel. A poor viscosity may also be a result of not soaking the glue for a sufficient length of time before heating it to the melting temperature. From our data we have concluded that glue should be soaked for not less than two hours before it is placed in the melting pots and brought up to the melting temperature.

Setting Up Polishing Wheels. We found that there were great variations in the results obtained with wheels set up by different men, and also that the same man would not do as good a job in the afternoon as he did in the morning. The pressure with which the grain is applied to the wheels is of great importance. It determines, for instance, the relative proportions of grain and glue, and also the amount of grain that is picked up by the glue. In the morning, when the men are fresh, they do a fairly good job. As they become tired, they fail to use sufficient pressure and to roll or pound the wheel in the grain for a sufficient length of time. Close supervision is of little avail on an operation where men tire quickly. To overcome this difficulty, we, therefore, developed a special machine for setting up polishing wheels.

The General Spring Bumper Corporation wheel setting-up

machine is shown in Fig. II. The machine consists of a pan for holding the polishing grain, below which is provided a steam-heated device for keeping the grain warm. The wheel to be set up is placed on the glue stand beside the machine, and the glue from an electrically heated, thermostatically controlled glue pot is applied to the surface of the wheel, as is the usual practice. The shaft carrying the wheel is then thrust into the jaws of the machine and the motor is started by means of a push button. Through a crank shaft arrangement, the wheel is carried to the back part of the pan, dropped or pressed into the grain and rolled forward. It is then lifted and the process repeated at the rate of approximately 100 cycles per minute. In thirty seconds the surface of the wheel will be covered with grain which is well pounded in. The wheels, therefore, which are produced in the afternoon are as good as those wheels which are set up in the morning. This is a pronounced contrast to the setting up of wheels by hand. Hand-set-up wheels become progressively poorer as the day wears on, and as the operators become more tired.

FIG. II

The operator applies the glue to the surface of one wheel while the machine is applying the grain to the wheel previously glued. The operator next removes the set-up wheel from the machine and places on the machine the wheel which he has just glued. By proceeding this way, substantially none of the operator's time is required for actually putting the grain on the wheel. One man using this machine can set up as many wheels as three men by the old hand method, and in addition he gets a better job.

Drying Room Conditions. We then turned our attention to other plant conditions and standardized the temperature of the drying room. An effort was also made to control humidity and to secure a good circulation of air throughout the drying room. Attention was also devoted to securing wheels which were true as contrasted to wheels which have a surface eccentric with the center of

rotation. These factors are all very important, but time does not permit going into a detailed discussion of them here.

Use of Wheels by the Polisher. There is a great difference in the work which is produced from a given wheel by different polishers. A study of the results obtained from each of the polishers in one department during a period of one week showed that the man who earns the most cents per hour is, in general, the man who gets the most from his wheels. Rapid polishing results from a proper use of the polishing wheel. It is not necessary to sacrifice wheel economy in order to obtain polishing speed. When men who abused the wheels were eliminated, production increased, and the cost of polishing supplies simultaneously decreased. In fact, by following out procedures such as indicated in the foregoing description, we were able to cut in half the cost of the polishing operation.

Sizing of Polishing Grain

About 1929, the General Motors Corporation, particularly Messrs. Phillips and Mosher, became interested in studying the sizing of polishing grain. Two major questions were involved. First, is closely sized grain superior to loosely sized grain? Second, is there a reliable method for testing the size of polishing grain? It is common practice to determine the size of polishing grain by sifting it through sieves. A representative sample of the grain should be obtained by completely emptying a new keg of grain, and taking a small sample from each part of the keg as it is being emptied. These small samples are thoroughly mixed, and 100 grams of the mixture are sieved through a selected set of screens to determine the screen analysis. For example, No. 60 grain would be screened on 50, 60, 70, 80, and 100 mesh screens. These screens should meet the Bureau of Standards' specifications for certified screens of the United States series. The screens are placed in a "Rotap" machine and run for a specified period of time. The weights of grain remaining on the several screens give the screen analysis. This procedure would at first glance appear to give a definite result. Accurate screening of closely sized grain involves, however, many problems which have so far been only partly solved. Variations in the speed of the "Rotap" and the force of the blow affect the result. Furthermore, no screens are perfect, and apparently no two screens are sufficiently alike to give duplicate results with any great degree of precision. This will be explained more fully in the latter part of this paper.

The grain does not consist of uniformly shaped particles. With a perfect screen, consistent results could be obtained if the material tested were composed of small spheres. The grain may, however, contain particles which are more or less oblong in shape. If these hit the screen in such a way that the small dimension comes opposite an opening, they may pass through, whereas they would not pass through if they landed with another surface towards the screen opening. The diagonal of the screen opening is greater than the dimension straight across, and this adds something to the complication. Furthermore, even if identical screens could be obtained, the rapid wear which accompanies their use would soon make them quite different. It has become evident that it may be necessary to use a sample of grain as a standard of size, and to calibrate screens by using this grain instead of accepting the screens as a standard.

The grain specifications in use prior to June, 1930, permitted nearly one-third of the grain to be retained on each of three successive screens. In June, at a meeting of the producers and users of grain held under the supervision of Mr. Dunn of the Simplified Practice Division of the United States Bureau of Standards, a closer specification was tentatively adopted. These specifications are known as the G.W.M. specifications. The users of polishing grain in the Detroit district, representing principally automobile and automobile parts manufacturers, were convinced on the basis of preliminary studies that superior results could be obtained with much more closely sized grain. After some exchange of ideas a number of manufacturers expressed a willingness to produce closely sized grain if the results justified the refinements in technic necessary for its production. The specifications adopted by the Detroit manufacturers, and known as the G.M.C. tentative specifications, are shown in Table I.

It should be noted that on the G.M.C. specifications most of the grain should pass the U.S. standard screen having the same number of meshes per inch as the grain number, and be retained on the next finer screen named in the specifications. Aside from the closeness of sizing, the G.W.M. specifications call for most of the grain being held on the screen having the same number of meshes as the grain number. For example, to replace a No. 60 G.W.M. grain, one should order G.M.C. No. 50 grain.

The results of a screen analysis of the same grain by different companies on different "Rotaps" using their own screens are most interesting. The diversity of results obtained with duplicate samples

of a particular grain show something of the difficulty of obtaining check results on what appears offhand to be a very simple test.

The results of two tests of alundum No. 80 grain furnished on the G.M.C. specifications are shown in Table II. This grain was tested by the General Motors Corporation and the General Spring Bumper Corporation. The results do not appear to check at all, but by reference to the calibrations of the screens, which are also shown in this table, it will be seen that this grain satisfactorily meets the G.M.C. specifications. This table, therefore, shows a portion of the evidence that such a calibration as we have just described may be a satisfactory method of checking grain size.

Enlarged views of two certified screens make apparent some of the difficulties. The tendency of grain to stick in the screens or "blind" them is clearly shown. Such blinding changes screen performance. Any but the gentlest efforts to dislodge this grain will cause the formation of larger holes and ruin the screen. Variations in the size of the openings in the screens are also shown. If the specifications for the screens were made so close as to eliminate all these variations, screens to meet the specifications simply could not be secured.

For this reason the Norton Company, which is endeavoring to lead the way to a really satisfactory method of checking the sizing of polishing grain, is experimenting with stainless steel plates, which have been perforated with circular holes, lapped to plus or minus 0.0002 inches for holes 0.075 inches in diameter, and hope to maintain substantially corresponding precision on other sizes. The few experimental perforated screens so far produced represent a variation of aperture size no greater than one-fourth of that of woven screens. The circular holes have only one diameter, whereas a single opening in the woven screen has a number of dimensions, depending on how the particle falls on the opening. The results of sieving tests on the perforated screens thus far, although entirely preliminary, are quite encouraging and indicate that this may prove the way out of the present difficulties. The successful application of the G.M.C. specifications depends on the ability to produce precision screens.

Comments on "G.M.C." Grain

Grain to meet the G.M.C. specifications is furnished on request by most, if not by all, of the larger grain producers. The reports on the use of grain meeting the G.M.C. specifications in comparison

to grain previously available are outlined by the following comments by certain users. These reports are taken from the minutes of an abrasive grain users' meeting at Detroit and the names of the individual users cannot be given. The following comments are, however, typical. Mr. A submitted a written report that a 39% gain was noted by the use of this grain. Mr. B stated that records of two products run show a gain of 32% on one and 28% on another. He also noted a considerable reduction in rejections. He stated that where five men had been used on this product, four would be sufficient with the improved grain. Mr. C stated that his company had rewritten their specifications to conform with the G.M.C. specifications. Mr. D presented a very detailed report covering comparative figures over a period of months on the old and new grain showing a considerable saving attributable to closer grading. The use of this grain also made it possible to simplify the polishing work on their product with the result that the new grain had been adopted as standard.

Experimental Work Now in Progress

At the present time two committees are at work under the auspices of the Simplified Practice Division of the United States Bureau of Standards. One of these committees is working on standards for testing sieves. The work of calibrating the sieves is being done by the Norton Company under the direction of Mr. H. O. Anderson.

Users in the Detroit district who have not already adopted the G.M.C. specifications for the purchase of polishing grain are continuing their experiments, comparing the results obtained with the two grades of grain. The Norton Company, on its own initiative, has for the past six months been working on a very ambitious research on the performance of polishing grain. In their research, however, they are using full-sized production polishing wheels, whereas in our first research we used laboratory scale equipment. In the program at the Norton Company great care is being taken to control all possible variables such as for example:

1. The uniformity and quality of glue used.

2. The concentration and heat treatment of the glue solution preliminary to setting up.

3. The uniformity of the wheels themselves as contrasted to the way in which the wheels are set up.

4. The uniformity and quality of the grain.

5. The temperature of the grain, of the glue, and of the wheel during setting up.

6. Control of the setting-up operation whether it be by hand or by machine.

7. Control of temperature and humidity during the treating of the wheel preliminary to its use for polishing.

8. Control of variables in the actual polishing operation itself.

Results are now being obtained on this research, but it will be some time before the research is completed.

TABLE I

Test of Alundum No. 80

	G.M.C. Specifications	*G.M.C. Screen Calibrations*	*G.M.C. Found*	*G.S.B.C. Screen Calibrations*	*G.S.B.C. Found*
On No. 70 Max.	None	None	Trace	None	Trace
On No. 80 Max.	10%	10%	15.6%	9%	7.1%
On No. 100 Min.	75%	95%	59.1%	86%	87.3%
On No. 120 Max.	25%	21%	24.5%	8%	5.3%
On No. 140 Max.	10%	10%	0.7%	5%	0.2%
Through No. 140 Max.	1%	None	Trace	None	Trace

CHROMIUM PLATING OF TOOLS AND GAUGES

By Lieutenant Willink, Frankford Arsenal

American Electro-Platers' Society, Philadelphia Branch
Friday, February 6

I have here a paper that deals with the application of chromium plating to tools and gauges. We found that this work has been a great saving to us with tools and gauges at the Frankford Arsenal, and I am going to endeavor to tell you a little bit about some of the methods we follow.

Going on with the paper proper—In recent years the process of chromium plating has attracted intense interest in practically all branches of industry. It has excited the interest of engineers and chemists to the solution of problems not in chromium plating, but to problems in general electroplating as well. Problems which have existed for a great many years. It has, in fact, tended to put the art of electroplating on a sound scientific basis.

The unique properties of chromium plate which have attracted such widespread interest are its hardness and wearing qualities,

its resistance to deterioration or discoloration under ordinary atmospheric conditions, also under conditions where smoke and fumes exist, such as in large cities. And its use in conjunction with other metals to prevent the corrosion of iron and steel, and last, its lubricating qualities. And associated with that, the difficulty of wetting a chromium plated surface. All these properties have either individually or collectively found application in countless numbers of industries. On account of the vast subject matter involved, it is deemed advisable to limit this discussion to just plating of tools and gauges.

It is not within the scope of this paper to discuss the historical development of the present-day chromium plating unit, and it is merely stated that the composition of solutions in general present-day use can be narrowed down to two. First, the solution that is used by the Bureau of Standards, containing about 33 ounces of chromic acid per gallon with perhaps about three-tenths of an ounce of sulphuric acid added. This solution is in quite extensive use in the Middle West. Some of our Eastern platers have preferred a solution containing 55 ounces of chromic acid and about three-tenths of an ounce of sulphuric.

Since Haring and Barrows, in the Bureau of Standards Technological Paper No. 346, have shown that the plating range of the 55-ounce solution is rather limited at high temperatures, we will not discuss this solution, as we are going to discuss the use of chromium solutions at high current densities and high temperatures.

Now the fundamental law of plating was a law that was gotten out a good many years ago by Faraday, known as Faraday's law. It says that the amount of metal that is deposited is governed by the quantity of electricity that is used in the plating process. The quantity of electricity is made up of two factors. First, the current; and second, the time of plating. Thus, it is the product of the total current and the time of plating. The amount of metal theoretically deposited by one ampere in one second is known as the electrochemical equivalent. I have here the electrochemical equivalent of chromium, which is about .6462 grains per ampere per hour. Or we can use it as a basis of thickness of plating when we specify a certain current density and we can say it is about two one-hundred-thousandth of an inch per ampere per square foot per hour. Actually, this theoretical amount of metal is never obtained, and this is particularly true in the case of chromium, on account of the copious evolution of hydrogen at the cathode and oxygen at the

anode, which, in fact, is an electrolysis of water. The ratio of what actually is obtained on the cathode to what should be theoretically obtained we know as the cathode efficiency. For chromium it varies from 7 per cent to 20 per cent.

A study of Faraday's law quickly reveals the fact that the more current we can pass through a solution, the more quickly can we obtain the desired thickness of plate. Thus, in harmony with modern views of production, the use of high current density is highly desirable. It has been the experience of the average plater in chromium who has raised his current density too high that he has produced a so-called "burnt plate," which in many cases is undesirable.

(Shows Chart on Screen)

This chart is really the key chart of chromium plating. Here you see the range of bright plate. You will notice that the difference between your upper limit and your lower limit of bright plate is rather narrow at that point. (25° C.). Now, let's raise the temperature a little bit and see what happens; you will notice our plating range widens considerably, and we don't have to watch our current density so closely. In other words, our general plating conditions become very much less critical.

That chart shows that we have been working under rather critical temperatures and current densities. Now by means of the information that was gathered in that chart, you can readily see that current densities of 1000, 2000 and even 3000 amperes per square foot are absolutely possible. And those current densities can be obtained without affecting in any way the brightness of the plate. By the use of about 1000 amperes per square foot, you can get about one-thousandth of an inch of plate in 15 minutes.

Now the current efficiency in this chart will run from about 7 per cent at the lower limit to 20 per cent at the upper limit, and it is therefore desirable to work as near the upper limit as we possibly can.

Now, the way this chart goes here, it seems to just widen out. The further up you get with the temperature, the more favorable conditions become. Well, that's not all peaches and cream, and when you get out here (into the high temperatures) you are running into some other difficulties, and let's just enumerate what some of these difficulties are. First of all, the chromium plating solution is going to boil off on you, when you get out to a certain point. Another thing, if you are using ordinary steam for heating, you are limited

to the temperature at which you can heat the bath. Another very practical limitation that the average plater will find is that his generating capacity will seriously handicap him. And one of the things that we have run into is the breakdown of insulators, the question of suitable insulators that will stand the high temperature of the chromium bath. That has been a rather serious problem, and we found, as far as lacquers are concerned, there is no real lacquer on the market that I can say is entirely satisfactory. Some are partially satisfactory. They work after a fashion, but I am not entirely satisfied with any lacquer that is put on the market.

Another thing that will limit you in your upper temperature limit is the escape of the gases evolved in the plating operation. You can readily see if you have a small place for the gas to get out that you are going to be choked up with gases. That will be another limitation.

All these things are limiting factors that we have got to consider when we look at this chart. It all looks very beautiful on paper, but we have to consider the limiting factors that are involved.

In the use of high current density, it becomes necessary to raise the voltage at the source of supply, and for this reason a generator, with a maximum voltage of 15 volts, is highly desirable. Fortunately, many plating generators are constructed with two independent armature windings so that the armature can be placed in series, and in that way a high voltage obtained.

One of the features of plating at high temperatures is the elimination of the necessity of very delicate control, not only on current density and temperature, but also on chemical composition. (Shows Chart No. 2.) Now I will show you this in a general way. This chart here shows the upper and lower limit of bright plate at various sulphate contents with respect to the current density. These solid lines show the limits at 25° C. The dotted lines shows the limit at 45° C. You will notice that the limits have been widened out considerably. Now we get up to 60° C. (about 145° F.) and your limits have widened out very much more, and it is an actual fact that you can run over quite wide variations in sulphate content and get away with it. And that eliminates the necessity of frequent analysis. However, this does not mean that the thing should go unchecked entirely. All you who have plated with chromium probably know your sulphate content will build up. And after a certain point, as you see by the way those limits taper off, it is desirable to get

your sulphate content down where it belongs. But it is not nearly as critical as it is under the solutions as they are usually operated.

In a similar manner the chromic acid content can vary over quite wide limits, but in order to secure good conductivity of the chromic acid solution, the contents should be kept to 33 ounces per gallon, plus or minus three ounces.

Another point, and perhaps the biggest point of discussion in the matter of chromium plating solutions, is the matter of throwing power. This likewise is afforded considerable improvement at high temperatures and current densities. It is only reasonable that an irregularly shaped object, where the current density will vary over a wide range, that better throwing power will result where this range comes entirely within the range of bright plate, as you saw in the first chart.

The next question that will probably arise in most minds is that as to whether or not the chromium or whether the chromium deposited under these new conditions of high temperature and high current densities is superior or inferior to plate deposited under ordinary temperatures and current densities. The answer is this: The property that determines the wearing qualities of chromium, plated on tools and gauges, is that of hardness. No satisfactory laboratory means have been devised to measure this property, and the only way an answer can be given is by quoting results of applications obtained at the Frankford Arsenal.

Resizing dies for 30 caliber tracer bullets, such as I have here, yielded an average of 25,000 pieces, compared to 4000 pieces on an unplated die. Now, by using current densities in the neighborhood of 1000 amperes per square foot, and approximately 70 degrees Centigrade, with the limited number of dies that had been tested at the time I wrote this, the average has been increased to 55,000. I just got these back, and these two have averaged 100,000 pieces.

In dial feed plates that are used on clip machines, unplated steel plates showed indentations after two or three weeks' use. Plates chromium plated under the old method showed scratches after about a month's service. When plated under conditions of high temperature and current densities, plates have been in service over three months without showing any scratches or indentations. It can be concluded from this that the plate has superior physical properties for this purpose when deposited at high temperatures.

Now, I have made a general résumé of the plating process itself, but there are other factors that we must consider to successfully

chromium plate tools and gauges. First, I will spend a little time on the cleaning of the metals prior to plating. This subject is one that has aroused considerable discussion, both in chromium plating and in other electroplating processes. Chromium, of all metals which are commonly used for plating, adheres better than any when the surface conditions are right. The cause of flaked plating in chromium can be traced to two things. First, the presence of foreign matter, such as grease on the work; and second, to the presence of a thin soda film on the work. The first condition is not very often encountered, since all platers are careful to thoroughly degrease the work. But the second condition is quite common, and it is due to a soda residue remaining from the alkali cleaners. It is therefore essential that every trace of this soda film be removed before plating. This is done by giving the work a bath in dilute acid after the alkali cleaning, which must be done with care, and precautions taken that the work is well rinsed; or it may be done by reversing the current for a short time in the chromium solution.

Recently, a very satisfactory method of cleaning has been put on the market. I have made some preliminary tests on it, and while as yet we haven't one installed in the Arsenal, we hope to have one very shortly. That is the use of a vapor cleaner. This makes use of an organic vapor which condenses on the work and dissolves the grease. We eliminate entirely the alkali bath, and consequently any failures of chromium plate which can be attributed to the soda film. (Shows picture of machine.) Here is a picture of the cleaner. You have here steam coils or electric heating units that boil dichloral ethylene, and a vapor forms and is prevented from rising out of the top of the tank by these condenser coils that extend around the tank. When a piece of work is immersed in the vapor, the vapor condenses and drops off, taking with it all traces of grease, and what work I have seen come out of this type of cleaner is, in my opinion, chemically clean. I have chromium plated several pieces that I have cleaned by this method and they have been entirely satisfactory. I believe that the use of this will eliminate altogether our cleaning problems.

Another factor which is of importance in gauge and tool work is the character of the steel that is used as a base for chromium plating. While nothing definite can as yet be said, it is a fact that the excessive evolution of hydrogen on hardened steel will in certain cases cause surface cracks, consequently resulting in failure of the whole tool. It is believed that a steel that has been given a water

quench without a subsequent drawback will give uncertain results when chromium plated. It is also believed that the performance of a chromium plated tool is related to the Brinnell number, or Brinnell hardness of a steel base. Nothing of a definite nature can as yet be given, but tests are under way so that definite conclusions can be drawn at a later date.

One of the advantages of chromium plated tools lies in the possibility of deplating and replating. This eliminates entirely the use of a chromium steel, since the chromium of the steel will tend to go into solution rather readily during the deplating operation. The preparation of the work before it is sent to the plating shop, and after it is received back from the plating shop, is a matter which must receive careful supervision. It is highly desirable that a smooth and accurate finish be given to the work in the grind room. Care should be taken to use clean wheels so that grinding checks will be avoided. The work is usually ground from one to three thousands oversize in the case of external work, depending on the diameter of the work. The plating is put on so that from one to two thousandths of it can be ground out in the finishing operation. Special wheels are provided by the leading manufacturers of grinding wheels which are suitable for grinding chromium plated work.

In order to secure a uniform or nearly uniform plate, on the surface to be plated, the mechanical set-up is of utmost importance. Depending on the particular piece at hand, a great variety of fixtures will be part of the equipment in a well equipped tool plating shop. Each fixture is designed to meet a particular problem. There are certain elements of design which are essential to the building of good fixtures. One is that the distance from the anode to the cathode be as nearly equal as possible. Another, that the work be readily removable from the fixture. In other words, the minimum amount of time should be consumed in setting up and taking the work from the fixture. Also, insulators, particularly those of non-ceramic materials, should be reduced to a minimum, and wherever possible should be used outside of the solution.

I have here some illustrations of fixtures that are used. Here is the fixture that we use for these dies. We have quite a number of them to plate, so it pays to make a rather elaborate fixture. The fixture consists of these bars of anodes that can be lifted up, and we have some insulators here which are hard yellow pine, which we found to be highly satisfactory as an insulator in the high temperature chromium bath. And we can set these things fairly close, your

dies can be put in there very readily, and the anodes set fairly close to the center.

Once in a while we get a job like this—a big resizing die for an artillery cartridge gauge. We only have one of them to do, perhaps, so this is the type of fixture that can be readily made up in a few minutes, and will serve the purpose. We hang an anode in the middle here. By the way, all our anodes are as far as possible antimonial lead. In some applications we have to use steel anodes, where a question of stiffness of the anode is of some concern.

Now, in this paper I have attempted briefly to define the fundamental principles that must be followed in order to successfully plate tools and gauges. It cannot be overemphasized that successful plating of gauges lies not only in the proper control of the plating operations, but in the co-ordination of tool room, engineering staff, and the plating shop, and the most successful enterprises will be those in which the three departments mentioned are co-ordinated under one management. In other words, it is a highly unsatisfactory situation where you have a situation of divided responsibility. If the thing is all under single control, the product is bound to be right, and there isn't the passing of the blame from one person to another. Because, as I have indicated in the paper here, there are quite a number of causes outside of the plating shop that give you unsatisfactory work.—(Applause.)

Question—What was the maximum temperature you said that bath could operate at?

Answer—Well, theoretically I would say about 200 degrees.

Question—Would that carry your highest current density?

Answer—If you had the generators to put it there. In other words, in any particular installation, you have got to look at all these factors that I have enumerated, and find out for yourself just what you can do about it; in other words, just how high you can go. Some people may be limited in heating equipment of the tanks. Other people may be limited in generator capacity, and all those things have to be decided in the particular installation.

Question—Is the same thickness of chromium plate used on all dies?

Answer—No, sometimes we get a little reclamation work and salvage out of the junk pile and put two hundredths of an inch of plate on and get away with it. That is two hundredths of an inch on that big resizing die. It hasn't been ground out yet, but it looks good.

Question—How long does it take to deposit ordinarily a couple thousandths?

Answer—About a half hour. A thousandth of an inch is fifteen minutes. Of course, there is one thing you have got to remember here; in your set-up you can only approximately calculate your current density. That is, you can measure your total current, but your current density is going to be a variable in there; you are not going to get that down exactly. In other words, you can get a good rough idea when you think you are running about a thousand amperes per square foot you can depend on about a thousandth of an inch plate every fifteen minutes.

Question—The diameter of that piece there looks to be about four inches. What size of anode did you use in there? Did you put it through the center of that?

Answer—Yes, we hung an inch and a half or two inch piece of lead pipe in there. Of course, you have got to center that thing fairly well, be reasonably careful with it so you distribute your plate uniformly. But whenever we can, we like to grind the work out after it is plated. It is usually a better job. I know of some people that do plate gauges right to size, and the thing is about as broad as it is long. Your set-up is much more complicated, but it is being done.

Question—What voltage did you use?

Answer—Depending on the thickness of the piece, we have run as high, on that big resizing die there, for instance, as 16 volts. Now this job here, on the small pieces, we probably use about six volts.

Question—You spoke of deplating. You said something about taking chromium out of the steel. Did you mean you were stripping the chromium off, or you actually took chromium out of the steel itself?

Answer—You actually take it out of the steel.—Stainless steel or chromium steel around chromic acid baths are just too bad.

Question—I can see where you get it right off the surface, but how did you get it out of a heavy piece of steel?

Answer—You get it out of the surface; in other words, it is soluble matter that forms part of the steel.

Question—You make part of your steel porous, don't you?

Answer—Yes, and it will fall away. That is exactly what happens. On a particular application here not so long ago, I had a piece of

what I thought was drill rod, and used it for an anode. It looked as if somebody bit it right off. We found out on analysis it didn't have such a lot of chromium in it, about eleven points, that was eleven hundredths of a percent, which was enough to cause that damage.

Question—In deplating, do you use the same solution, reverse current?

Answer—Yes, the same bath.

Question—You don't strip any chromium plated stuff, then, in muriatic acid?

Answer—No. We strip it right in the chromium solution, just reverse the connections.

Question—Do you plate with nickel on steel first?

Answer—No, directly on the steel. We use no intermediate plate for hardness. The only place where we will use an intermediate plate is for anti-corrosive purposes. Sabers, bayonets, and that sort of thing. Of course, the principal reason there is to give you something flashy and bright.

We are not after anti-corrosion. We want wearing qualities. In other words, it is not an anti-corrosion problem.

Here is a knurling tool. We used to change those things about every couple of days. We have got some of them now that have been running a couple of months without a change.

Question—The fact that the chromium plating cracked the steel, as you mentioned before, doesn't mean the steel is no good, does it?

Answer—It was no good for that particular purpose.

Question—Was it no good for plating or no good for a tool?

Answer—It may be good for a plain steel tool, but certainly no good for a chromium plated tool, if you are going to crack it when you chromium plate it.

Question—Plating at higher current densities and higher temperatures certainly must involve a greater expense, does it not?

Answer—No. It involves a less expense, because you can turn out more work per day.

Question—But how about the electrical energy?

Answer—Your electrical energy cost is the same, or, if anything, slightly less, as power costs go. You have got, as I stated in the talk, according to Faraday's law, in order to deposit a certain amount of metal, to use a certain quantity of electricity. That is

your current multiplied by the time, and if you can do that quickly, your time factor goes down considerably, so that as far as actual power that is consumed, that would be the same. But if you use large blocks of power and have a heavy demand and keep it more or less steady, of course your unit cost of power goes down.

Question—Is there more resistance in high temperature baths than in low temperature?

Answer—There is a lower resistance, greater conductivity. The Bureau of Standards has gotten out a paper here recently on conductivity and density of chromic acid solutions. They show a considerable increase in conductivity. That is another decided advantage that you have a greater conductivity at higher temperatures. That is Paper No. 198.

Question—What method do you use for cutting down your sulphates?

Answer—Barium carbonate. We put that into the solution. You have to figure it out according to chemical equation. I have no arbitrary factors. We don't often do it, but once in a while it gets a little high, and we get it down to normal again.

Question—Is that more satisfactory than barium chloride?

Answer—Yes. Chlorides are a bad thing to have around chromium. Chromium and chloride are two things that don't agree, and chlorides are a thing that it is highly desirable to keep out of a chromium solution, and the barium carbonate, I think, is universally used. You get an effervescence when you put your barium carbonate in there, due to the liberation of the carbonic acid.

Question—You don't filter the bath after you add your barium carbonate, do you?

Answer—No, it just settles to the bottom as a sludge. We find that the expense of a suitable filtering equipment will run into considerable money, and it is not worth the additional expense.

Question—That hasn't any detrimental effect on the bath, by leaving it in the solution?

Answer—Oh, no. It all settles. Here is the equation for that:

$$Ba\,CO_3 + H_2O + SO_4 = Ba\,SO_4 + CO_2 + H_2O$$

Question—Suppose you took a piece of steel from an alkali cleaning solution and reversed the current in the chromium bath to remove the film; wouldn't that make the steel passive?

Answer—No. It does not. I have never found a piece of passive steel that would not take a plate.

Question—Could you deplate a piece of steel and reverse your current and replate it?

Answer—Absolutely. We do that right along. I never found a piece of steel I couldn't plate.

Question—Did you ever try it on nickel, reversing your current?

Answer—No. Our experience with nickel at the present time has been rather limited.

Question—Is it true that all the work that you are working on has been freshly ground?

Answer—No, as I say, some of it has been deplated work, and we switch it right around.

Question—The under surface is in pretty fair shape, even if deplated?

Answer—Yes.

Question—I think that question related to an oxide film.

Answer—Oxide films don't interfere much in chromium; you have such an evolution of hydrogen that any oxide that may be formed on the surface is quickly reduced, and it is something we don't worry about at all.

Question—A piece like that on the table there, would you hang that in your chromium solution with the current off, and then throw the current on—have it standing in the solution without the current being on?

Answer—Oh, yes. The time ordinarily that it takes a man to put it in. He cuts the switch until after it is in there so there are no short circuits.

Question—Did you ever take a piece out, that you had deplated, and threw your switch on your regular plating side, and taken that piece out a minute afterward to look at and see if it had started to plate at all?

Answer—No, we make a practice not to take the work out until we think it is done.

Question—The reason I asked that, I had some trouble myself with that, because we don't plate a half hour or an hour; it is usually three or five minutes, and I have seen occasions where I have reversed the current in the alkali cleaning solution before I

plated it and it wouldn't plate. That is w. y I was wondering if after it was in for any length of time the evolution of hydrogen would take that passive film off.

Answer—I think it will. I never ran into any such difficulties. One practice I insist on with our platers is to keep the work in the tank until it is done; in other words, this business of taking it out and looking at it is not the best kind of plating practice, in my opinion.

To You: Fellow Members of the
American Electroplaters' Society:

For months past you have been hearing about the new Research Associate that our Society is now maintaining at the Bureau of Standards at Washington, D. C., and it is with pleasure that I can state, as Chairman of your Research Committee, that progress is again being made. The many new things developing from our January meeting will soon be in form to publish in our REVIEW; it is the consensus of opinion of all the attendants at this meeting, which of all the meetings held was of greatest importance to the future activities of the Society.

My reason for addressing you at this time is to ask you to realize the necessity of progress in our study of electro developments in all its phases, and to ask you to read our appeal in your REVIEW and to interest your employer in the necessity for funds to keep and continue this new investigation in progress. The fund is being used to meet expenses of labor. The U. S. government donates the place, and the A. E. S. donates its service and money in the administration and care of the funds, so that subscribers can receive full value for their money.

Will you help the Research Committee?

JACOB HAY, *Research Chairman.*

Mr. Proctor calls our attention to an error in the March REVIEW following the reading of Mr. Clindinin's paper on "Low pH Nickel Solutions," and we are glad to make this correction. The following formula is correct:

Water	1 gallon
Single nickel salts	50 ounces
Nickel chloride	4 ounces
Acetic acid 100% glacial	1 ounce

GOLD SOLUTIONS

By Oliver Sizelove, Newark Branch

Read at Bridgeport Annual Meeting, March 21, 1931

Gold is one of the most malleable and ductile metals, and readily alloys with most metals. When pure, it is of a yellow color, becoming pale by the addition of silver and red by the pressure of copper.

Pure gold does not tarnish and is not attacked by any of the single acids (selenic acid being excepted). It is readily soluble in aqua regia; a mixture of hydrochloric and nitric acids, two parts of hydrochloric and one part of nitric acid being the combination which is generally used. It is also to some extent soluble in potassium or sodium cyanide. This fact is applied in the cyanide method of extracting gold from its ore.

No other metal lends itself to the variety of shades or color as does deposited gold. There is no set standard of weight for the metal deposited as there is with silver, and the least amount of gold that is used to produce a satisfactory color, especially on novelty and cheap jewelry work where competition is close, is quite an item in the cost of the article. The operation as usually practiced is to produce a satisfactory color as an ornamental finish, and then to protect the finish by the use of lacquer.

The three different methods of depositing gold that are in general use are the cyanide method, the salt water method, and the immersion method.

Cyanide Method

When the deposit is to be of any specified thickness or wearing qualities, the cyanide gold solution is always used. The gold may be introduced into this solution either as the fulminate of gold or as gold cyanide. Besides a small amount of free cyanide which is necessary, sodium phosphate is added as a conductor. The amount of metal that is used in the solution varies greatly and is usually governed by the class of work being done.

The following formula is the one that can be used on all classes of work by increasing the metal concentration as desired:

Metallic gold (as fulminate or cyanide)	5 pwt.
Sodium or potassium cyanide	2 ozs.
Phosphate soda	1 oz.
Water	1 gallon

The color of the deposit varies greatly by the temperature and current density used; also by the metal concentration and the free cyanide content.

It is possible to obtain from this solution a pale 16 karat color to a rich yellow 24 karat color by changing the temperature and current density. If operated at room temperature and a low current density, a pale 16 karat color is produced. If operated at 130°F. and the current density is increased, a good yellow color is produced. If the temperature is increased to 175°F., a red color is obtained.

In gold plating novelty work when only a flash of gold is desired for "color," the cyanide of gold solution has not proved as satisfactory in some cases as either the salt water or immersion methods. It can be readily seen from the remarks on cyanide gold solution that careful adjustment of the temperature, current density, metal concentration, and the free cyanide content of the solution must be maintained constant at all times to produce uniform results.

Salt Water Method

The salt water gold method is recommended for most novelty work, for less difficulty is had in producing a uniform color, as there are less factors to be controlled with this method of gold plating. The salt water gold solution is simple to make, easy to operate, and very little care is required in its operation. More work can be produced from this solution at less cost than with the cyanide solution.

With this method the gold solution is placed in a porous pot which is surrounded by a cylinder of zinc and placed in a tank which contains a saturated salt (sodium chloride) solution.

The salt water is heated to 150° to 175° F., and if steam is used, the coil should be made of brass or copper tubing. If gas is used to heat the salt water solution, the tank that holds the salt water solution should be made of copper.

An upright bar is fastened to the zinc cylinder to which is attached a cross rod upon which the work is suspended into the gold solution.

An electrolytic action is produced by the action of the salt water on the zinc, and thus furnishes the electromotive force by which deposition of gold takes place. In other words, the gold is precipitated out of the solution and on to the work by being in contact with the zinc cylinder.

There are different variations in the amount of chemicals that are used in preparing the gold solution, and it does not seem to matter greatly what the proportions are, for little trouble is had so long as the solution is replenished with gold from time to time.

The following formula is used with excellent results:

Potassium Ferro cyanide	16 ozs.
Sodium phosphate	8 ozs.
Sodium carbonate	4 ozs.
Sodium sulphite	2 ozs.
Gold as fulminate	3 to 4 pwt.
Water	1 gallon.

The chemicals and gold with a small amount of water is placed in an enameled vessel, and boiled for at least an hour before placing in the porous pot and diluting with water to the proper volume.

In replenishing the solution, the same amounts of gold and chemicals are taken and boiled thoroughly and added to the solution. A red deposit is an indication that the solution has become depleted in metal, and it is then necessary to replenish the gold solution.

When the solution works slow, it is usually found that the salt water solution has become weak and more salt should be added. The salt water should be kept at a Beaume reading of 12° to 15°.

Too much gold should not be added at one time, as this will cause a smutty deposit: so will the use of too high a temperature. 140° F. is an ideal temperature at which to operate the gold solution.

It might be well at this time to give method of preparing the "fulminate of gold."

A weighed amount of gold is taken, preferably ribbon gold which is cut into small pieces and to each ounce of gold 8 fluid ounces of aqua regia (2 parts hydrochloric acid and 1 part nitric acid) are used. Put the gold and acid into an evaporating dish and place on a hot water or sand bath under an exhaust hood and let the gold dissolve. When the gold is dissolved, it is diluted with water and 26° ammonia hydroxide which is diluted one half with water, and added until the gold is precipitated. This is indicated by the faint odor of ammonia, or by the use of red litmus paper which turns blue. The precipitate is allowed to settle and the clear solution siphoned off. More water should be added and siphoned off until the odor of ammonia has been removed. After the last siphoning

operation, the gold fulminate is placed in a bottle until ready for use.

As fulminate of gold is explosive when dry, it should at all times be kept covered with water when placed in the bottle.

Gilding by Immersion

Gold is a very electro-negative metal so that any of the common metals are capable of replacing it when in solution. It can therefore be deposited by simple immersion, and this fact is made use of when a very thin film of gold is desired. It is used mostly on the cheapest class of gold plated work, and when properly done presents quite a pleasing finish.

The solution is prepared from the following chemicals:

Yellow prussiate potash	24 ozs.
Carbonate soda	12 ozs.
Caustic soda	¼ oz.
Sesqui chloride iron	⅛ oz.
Gold as fulminate	3 pwt.
Water	1 gallon

If the deposit is too light in color, which is usually the case when the solution is first prepared, the addition of a small amount of copper cyanide that is just taken up with sodium cyanide will darken the color of the deposit. There should be no free cyanide in the solution.

The required amount of chemicals and water are placed in a cast iron tank, preferably of the steam jacketed type, and boiled for an hour or so. The solution is then cooled to 140° to 150° F., at which temperature the solution operates best. Large quantities of small work can be done in this solution, and an even deposit is obtained.

When the color of the deposit becomes too red and the solution works slowly, it should be replenished by adding fulminate of gold and boiling for an hour or so before using.

The solution, when first prepared, will register 15° Beaume. When the reading is 12° Beaume, the solution should be replenished with chemicals using ¼ of the amount given in the formula.

Green Gold

Green gold deposits which are usually an alloy of gold and silver, although cadmium has been used in the place of silver in some instances, are best prepared from the cyanide of the metals. The porous pot method can also be used, and this consists of making a cyanide solution of 4 ozs. of sodium cyanide and water 1 gallon, which is to be used as the plating solution. Green gold anodes of the proper alloy are hung on anode rod and a porous pot that contains a cyanide solution is attached to the cathode rod, and into the porous pot is suspended a copper cathode. Electrolysis is employed, and the anodes are taken from the solution and weighed from time to time so as to determine when the proper amount of gold has been taken from the anode and put into the solution.

Green gold solutions are best operated at a temperature of 95° to 100° F. The temperature plays quite an important part in producing the desired shade of color. A rise in temperature will increase the percentage of gold in the deposit. A low current density and a low free cyanide content also aids in producing a deposit that is more yellow.

The operating conditions of a green gold solution are similar to those of a brass solution, for the factors that tend to deposit a high copper alloy will also produce an alloy in which the gold is high.

Green gold deposits can also be obtained with the salt water type of solution.

When the silver is added to a salt water gold solution, the silver in the form of a chloride should be put in the solution by boiling with yellow prussiate of potash and then added to the solution.

In preparing cyanide green gold solution 5 to 6 pwt. of metallic gold, either as fulminate or cyanide, is used to each gallon of solution, and two ounces of sodium cyanide is enough to put the metal into solution and also give a free cyanide content that is sufficient. The silver as silver cyanide should be added cautiously until the desired shade of color is had.

Antique green gold solutions are produced by adding a lead or arsenic salt to the green gold solution. The lead salt is preferred, and it is taken up with caustic soda, and then added to the solution in small quantities.

Antique green gold solutions are operated with quite a high free cyanide content, and also a high current density; 5 to 6 ounces of free cyanide being used with 4 to 6 volts pressure.

White gold and 14 karat gold solutions are prepared by adding to the cyanide gold solution nickel or copper respectively, in the form of cyanide until desired color is obtained.

Rose gold solutions are fine gold solutions to which caustic soda or potassium carbonate or both are added in sufficient quantities to produce a smut effect with the deposit. The high lights are relieved with bicarbonate of soda, leaving the rose or smut effect in the background. The effect is very pleasing when properly done.

THE NEWARK BRANCH

takes pleasure in extending a cordial invitation
to all members, their friends and others
interested in the art of electroplating
to attend their

Thirteenth Annual Banquet

TO BE HELD AT

the Elk's Club, Broad St., Newark

On Saturday, April 11, 1931, at 7 p.m.

Educational Session at 2:30 p.m.

Mr. Philip Sievering will preside. Papers relating to the plating industry will be read and discussed.

GEORGE REUTER,
Secretary Newark Branch.

A. E. S. PAGE

Now that the Rochester Convention is drawing near, it might be well to remind those of our membership who contemplate sending exhibits that they must give full information as to the formula used and the various methods employed in finishing the articles exhibited in order to become eligible to compete in the awards which the Convention offers yearly. We have seen some splendid specimens of plating, lacquering, and oxide finishing eliminated because of failure on the part of the exhibitor to give the desired information which is a prime requisite when the committee announces the winners.

* * *

We have received a letter from Mr. T. C. Eichstaedt of Detroit Branch which will be of interest to our readers. Mr. Eichstaedt says:

It is very gratifying to note that the reports of the branches are increasing in interest, and that there are twice as many branch reports in March issue than in February issue, and I trust that the branches which are not represented in March issue will appear in April issue. If the branch secretaries will just make their reports every month, so that all the readers of THE REVIEW will get the benefit of what the branches are doing, I am sure they (the secretaries) will feel that they are not only helping their readers, but that they are also doing their branch a double service, as it pays to advertise.

It is very interesting to note how many of our branches are organizing chemistry classes. Also very gratifying to see how our Educational Committee is helping the branches to organize these classes. Keep the good work up, as knowledge is power.

One thing I have noticed in different articles and in some of the reports of our branch secretaries published in THE REVIEW, and which I think should be eliminated, and that is the use of chemical terms such as $Na\ S_2\ O4$, etc. We are not all chemists, and for the present at least THE REVIEW is for the benefit of the plater, and what benefit can he obtain of the articles, etc., if with these different terms there is not the common name of the chemical used? These articles are O.K. for those who have the chemical education, but the majority of electroplaters today do not have it. Therefore, in our REVIEW at least, there should be with the chemical term the common name also, so that all who read may know.

There is now great need for a common understanding among the electroplaters of all the new and progressive processes and solutions, etc., but in order that all may benefit by them as published they should be published so all can understand them.

* * *

The readers of THE REVIEW will notice the very excellent papers read and discussed at the educational sessions of the various branches, there are, however, a number of articles just as good that are not given to us for publication in THE REVIEW. Some branches do not send in any of their papers. Let's have them all for the common good even if we have to make our magazine larger, and in this connection be sure that the copy is correct before we turn it over to the printer for publication.

PRESIDENT'S LETTER

The following district chairmen have been appointed during the past month:

District No. 1 — Mr. Jacob Zwisler
District No. 2 — Mr. Harold Faint
District No. 3 — Mr. Bernard Lewis
District No. 4 — Mr. C. Kemish
District No. 5 — Mr. Paul A. Oldam
District No. 6 — Mr. G. A. Lux
District No. 7 — Mr. Chas. Campbell
District No. 8 — Mr. Ellsworth T. Candee
District No. 9 — Mr. Marcus Rynkofs

These district chairmen will get in touch with all the branches in their districts and the branches are kindly requested to cooperate with their district chairmen, and branches who have not appointed their representatives are requested to do so at once, for by doing so, it will be possible for your district chairman to get papers and speakers listed for your meetings, and this is one of the first essentials to getting the members interested in the meetings of your branch.

It is also well for the members to remember that the better the attendance at your meetings, the better the discussions will be, and the better the discussions you get at your meetings, the better the opportunity of getting better papers and speakers at your meetings.

We expect mistakes will be made in getting this Educational Bureau to function properly, but if we give these district chairmen our cooperation, these mistakes will be ironed out and we will have an Educational Society any body of men can well be proud of.

Now let's get together and give all the assistance we can to these district chairmen and they will see to it that you have interesting meetings in your branch.

The following is the list of the branches' representatives together with the speakers in their respective districts.

DISTRICT 1

St. Louis, Indianapolis, Anderson, Cincinnati and Dayton Branches

JACOB ZWISLER, Chairman

Branch Representatives

St. Louis .....
Indianapolis .....
Anderson .....
Cincinnati .....
Dayton .....Jacob Zwisler, 1269 Leonard St., Dayton, Ohio

SPEAKERS

Walter Fraine ..... 507 Grand Ave., Dayton, Ohio

DISTRICT 2

Chicago, Milwaukee and Grand Rapids Branches

HAROLD FAINT, Chairman

Branch Representatives

Chicago .....Harold Faint, 6908 Hilldale Ave., Chicago, Ill.
Milwaukee .....H. G. Binder, 602 Lafayette Ave., Racine, Wis.
Grand Rapids ...

SPEAKERS

Harold Faint ..... 6908 Hilldale Ave., Chicago, Ill.

DISTRICT 3

Toledo, Detroit, Cleveland and Pittsburgh Branches

BERNARD LEWIS, Chairman

Branch Representatives

Toledo ....Stanley Moore, 1153 W. Woodruff Ave., Toledo, Ohio
Detroit ....Bernard Lewis, 10398 American Ave., Detroit, Mich.
Cleveland ....J. C. Singler, 3379 W. 95th St., Cleveland, Ohio
Pittsburgh .....

SPEAKERS

B. F. Lewis ..... 10398 American Ave., Detroit, Mich.
Jos. Hansjosten ..... 14016 Rochedale Ave., Detroit, Mich.
J. F. McCoullough ..... 4255 Lincoln Ave., Detroit, Mich.
W. W. McCord ..... 16209 Baylis Ave., Detroit, Mich.
Dr. C. G. Soderberg ..... 3220 Bellevue Ave., Detroit, Mich.
J. Hergist ..... 12540 Forest Road, Cleveland, Ohio

DISTRICT 4

Toronto and Montreal Branches
C. KEMISH, Chairman

Branch Representatives

Toronto ....C. Kemish, 271 Boston Ave., Toronto, Ont. Canada
Montreal ...

SPEAKERS

DISTRICT 5

New York, Newark, Philadelphia and Baltimore-Washington Branches
PAUL A. OLDAM, Chairman

Branch Representatives

New York .... Henry Levine, 3504 Hull Ave., New York, N. Y.
Newark .... Paul A. Oldam, 27½ Ogden Ave., Kearney, N. J.
Philadelphia Dr. A. K. Graham, 6717 N. 6th St., Philadelphia, Pa.
Balto.-Wash. Dr. Wm. Blum, Bureau of Standards, Wash., D. C.

SPEAKERS

Jos. Haas ..... 291 E. 205th St., New York, N. Y.
Chas. H. Proctor ..... 264 Argyle Pl., Arlington, N. J.
Dr. L. C. Pan ..... 419 W. 115th St., New York, N. Y.
Wm. Voss ..... 8620 130th St., Richmond Hills, L. I., N. Y.
Dr. Colin G. Fink ..... Columbia University, New York, N. Y.
Dr. Hiram S. Lukens Harrison Laboratory, U. of P., Phila., Pa.
Dr. A. K. Graham .. Harrison Laboratory, U. of P., Phila., Pa.
Dr. Wm. Blum ..... Bureau of Standards, Washington, D. C.
Geo. B. Hogaboom ..... Box 30, Matawan, N. J.
R. W. Mitchell ..... Garwood, N. J.

DISTRICT 6

Rochester Branch
G. A. LUX, Chairman

SPEAKERS

R. E. Pittit ..... 2050 Elmwood Ave., Buffalo, N. Y.
Frank C. Mesle ..... Oneida Community Co., Sherrill, N. Y.
Arthur Thurber ..... Oneida Community Co., Sherrill, N. Y.

DISTRICT 7

Boston, Worcester and Providence-Attleboro Branches
CHARLES CAMPBELL, Chairman

Branch Representatives

Boston ..... Charles Campbell, Boston Nickel Plating Co. Portland St., Boston, Mass.
Worcester .... Milton H. Frommann, Reed & Prince Mfg. Co., Worcester, Mass.
Providence .....

SPEAKERS

DISTRICT 8

Bridgeport, Waterbury and Hartford-Connecticut Valley Branches
ELLSWORTH T. CANDEE, Chairman

Branch Representatives

Bridgeport Thos. Chamberlain, 859 Orange St., New Haven, Ct.
Waterbury Ellsworth T. Candee, 1120 Baldwin St., Waterbury, Ct.
Hartford-Connecticut .....

SPEAKERS

DISTRICT 9

Los Angeles and San Francisco Branches
MARCUS RYNKOFS, Chairman

Branch Representatives

Los Angeles .. M. Rynkofs, 1355 W. 25th St., Los Angeles, Calif.
San Francisco .....

SPEAKERS

F. C. Rushton .... 1127½ La Veta Terrace, Los Angeles, Calif.
G. W. Kyle ..... 3117½ W. 3rd St., Los Angeles, Calif.
P. A. Boeck ..... 1736 N. Gramercy Pl., Los Angeles, Calif.
T. H. McClain ..... 428 N. Louise St., Glendale, Calif.

GEO. GEHLING, *President.*

BRANCH NEWS

BOSTON BRANCH

Boston Branch met Thursday, the 5th, at the American House, with President Gale in the chair.

After the regular order of business, a report of the chemistry class was made by the chairman, Mr. Campbell, who stated that there are now twenty-three members in this class and that the class is going along better than was expected, every member working hard to learn everything he can. It looks now as though we will have a much bigger class next fall if the platers around Boston care to join this class. The committee have worked very hard to make it a success, and deserve a lot of credit, and also Mr. Cahill, our instructor.

We had with us Mr. Wm. Chase of the Baltimore-Washington Branch. He spoke first on the coming convention to be held this year at Rochester, N. Y., and urged all those that could to attend. He also spoke on "Lacquers." He gave an outline of the various methods used, the different kinds of lacquers, the troubles encountered, and the many uses and advantages of lacquers. He showed some of his samples, which were very interesting, and a vote of thanks was given Mr. Chase for his very interesting talk.

The meeting adjourned at 10:15 p.m.

A. W. GARRETT, *Secretary.*

CLEVELAND BRANCH

The members of the Cleveland Branch held an open meeting on Saturday evening, March 7, at Hotel Winton, with their wives and friends as guests.

Mr. J. C. Mullinnix introduced President E. Steen Thompson, who, after a short address, explaining the method of true color photography, threw on the screen pictures of the lilacs, peonies, rhododendrons and other flowers in Highland Park, Rochester, N. Y. Also garden scenes from the locality in which he lives. After the lecture President Thompson answered questions as to the planting and care of shrubs.

A rising vote of thanks was given to President Thompson for his splendid lecture. After the pictures a social hour was enjoyed with refreshments.

PAUL STAMM, *Secretary.*

HARTFORD-CONNECTICUT VALLEY BRANCH

The Hartford-Connecticut Valley Branch held its regular monthly meeting in the Hotel Kimball, Room 218, Springfield, Mass., on Monday evening, February 23, 1931.

The meeting was called to order at 8:30 p.m., with President Beloin in the chair. Minutes of the previous meeting were read and approved. All communications were read and placed on file. The Branch

donated fifty dollars ($50.00) to the Research Fund. It was voted to drop the idea of an educational session and banquet for this year, and, instead, to turn out a good crowd to the Bridgeport Branch educational session and banquet.

Mr. Kennedy and Mr. Sederlund gave some interesting remarks concerning the analytical class, which is being conducted by Mr. Flowers.

Mr. Beers, of the Lyman Beers Co. of Springfield, gave a very interesting talk on "My Experience in the Polishing, Buffing and Plating Supply Industry." His talk was very interesting, and in it he mentioned some of the troubles encountered in that business, also some of the humorous things involved. His talk was enjoyed by all of us, and in conclusion was given a rising vote of thanks.

The meeting was attended by nineteen members, and was adjourned at 10:30 p.m.

VERNON E. GRANT.

NEWARK BRANCH

The regular meeting of the Newark Branch, A. E. S., was held on Friday evening, February 20, 1931, at Franklin Hall, with President Calabrese presiding and an attendance of 52 members.

Application of Mr. Frank P. Baule was received. Ordered take regular course.

The Newark Branch will hold a card party and dance on March 6, 1931. The committee of which Mr. George Wagner is chairman has arranged a very enjoyable evening for all who attend.

The chairman of the Banquet Committee, Mr. Wm. Harrison, has arranged a splendid program for the Newark Branch's banquet to be held on April 11 at the Elks' Club in Newark, N. J. The afternoon session will be in charge of one of Newark Branch's esteemed members, Mr. Sievering, and a program of a practical nature is the order.

Mr. Smith requested the members of Newark Branch to try and attend the Rochester Convention.

The speaker of the evening was Mr. Lewis Graham of the Connecticut Dynamo Co., a member of Newark Branch. His subject was "The Electrical Side of Plating."

Starting with what is voltage, its creation, its application to electroplating. How the commutator rectifies the current generated. The voltage at the anode, the cathode and the solution.

The voltage drop across the solution. The voltage drop at the cathode, the voltage drop at the anode.

Polarization on the cathode was explained, as well as single potential which varies with ion concentration. Drop in potential, loss in potential.

Hydron over-voltage is also described at length.

Questions were asked by the members and considerable discussion was held on how to increase amperage, decrease voltage. The conclusion which

the speaker and members arrived at was to do the above you would have to decrease resistances.

This splendid practical talk was indeed educational, and a rising vote of thanks was tendered Mr. Graham by the members of Newark Branch.

GEORGE REUTER, *Secretary.*

LOS ANGELES BRANCH

The regular monthly meeting of this Branch was held as usual the 2nd Wednesday of the month, February 11, for the first time on the 8th floor in the Los Angeles Chamber of Commerce Building.

The selection of this ideal quarters for the Branch's monthly meetings and other affairs was made by brothers Kyle & Rynkofs, who made arrangements with the Chamber of Commerce officials.

To celebrate the first meeting at the new address it was decided to hold an open smoker meeting, at which there were sixty present.

The routine of business was carried off as quickly as possible, admitting two new members and one new applicant.

Banquet arrangements to be held March 14th were ironed out. M. McNulty, chairman of the committee, outlined the features which will prevail at this yearly gathering.

We were exceptionally well fortified with speakers this night. In all there were 60. The three principal ones were:

Percy A. Boeck of the Oakite Products, Inc., gave a 15-minute talk on "The Cleaning of Metal Preparatory to Plating."

Prof. S. Fischer, local Professor of Physics and Chemistry, interested us in his subject, "Efficiency in a Plating Shop."

And 20 minutes of "Life of Plating Trade" and "A Little History of Chromium" was read by our yearly visitor, E. Lamoureux of the Chicago Branch.

The three above speakers received a great ovation.

The following questions were found in the question box:

Question—Are there any brass or bronze die castings?

Answer—Yes.

Question—Any information in regard to chromium expert from the East canvassing California?

Answer—Lay off any of these so-called experts.

Question—Why is it that a casting of iron that has been pickled a long time in a muriatic acid dip will not take a hard surface chrome plate? Either direct or on copper strike.

Answer—You must neutralize the acid before polishing.

Question—What effect does electric current have on a metal cleaning solution? Why does it seem to kill the cleaner?

Answer—It has no effect on the cleaner, unless solution is very weak and the reverse current is used.

Question—How would you put a Verde antique finish on gray iron without the use of lacquer?

Answer—The formula was given as water 3 qts., chloride of calcium 4 oz., chloride of ammonia 4 oz., nitrate of copper 4 oz. Brush on work and stipple.

A motion to adjourn was carried at 10:30 p.m.

M. D. RYNKOFS, *Secretary.*

DETROIT BRANCH

March 14 was a great day in the history of Detroit Branch. The annual Educational session and dinner took place in the Hotel Fort Shelby on that day. The Educational feature was the address of Dr. Oliver P. Watts, whose discourse on hot nickel solutions was very instructive and was received with much interest. Dr. Watts told of the experience of 23 platers with the hot solution, all of them in successful operation using a temperature of 90° F. to 160° F., the usual temperature being 120° F. The pH ranged 2.2 to 6.5, while the current density used was from 10 amperes to 100 amperes per square foot.

In his summary he stated: "After making due allowance for the difference in form and size of the article plated and for the different thickness of plate desired, the wide variations in composition and operating condition given in the summary show that some companies are getting only one-third to one-quarter the output in nickel deposited per gallon of solution that others are securing, i.e., they have a plating plant three or four times bigger than they need if they would modernize their solutions and methods."

On the low pH solution Dr. Watts said: "In the battle of the pH's now raging the burden of proof rests with the newcomer, but if the advantage claimed for the low pH solution are not offset by its lower current, efficiency, poorer throwing power and fitting a new pH will be crowned king over the realm of nickel plating. The speaker is securing tough and remarkably adhesive nickel deposits at 224 to 248° F. and a pH below 0.8."

Dr. Watts also stated: "Gas pitting has doubtless discouraged many promising higher temperature and current densities, but what others are doing successfully you can do."

Mr. Louis J. Flint of the Detroit Board of Commerce delivered a splendid speech that stirred the enthusiasm of those in attendance.

Mr. Jos. H. Hansjosten spoke on "Cost Control," and told of some of the methods he used in keeping the cost line down.

Our old friend Mr. Ed. Lovering opened the meeting, and Ed.'s humorous remarks made everyone feel at home.

The committee provided everything that man needs. The vaudeville acts were fine, the dinner excellent, the jokes fairly new, some of them even new, and if anyone didn't have a good time it was because he was absent.

The one thing that pleased us most was the goodly number of plant managers and superintendents present. We appreciated this presence, and we hope we will have many more with us next year.

The program closed with a moving picture showing the electro-deposition of rubber, loaned to us by the Eastman Kodak Co.

We now extend to our neighbor branches in Toledo, Grand Rapids, and Cleveland an invitation to be with us next year and help us make our affairs a greater success, and we will reciprocate and help make their affairs successful.

CHAS. M. PHILLIPS, *Secretary and Treasurer.*

NEW YORK BRANCH

The New York Branch of the A. E. S. held their banquet at the Aldine Club, February 21, 1931, in which 368 diners participated. All had a wonderful time.

Chairman of the Banquet Committee, Joe Musante, after a brief address of welcome, introduced Mr. Charles H. Proctor, as chairman of the Educational session. Mr. Proctor thanked the members for the honor on this occasion, and hoped to be with us on many more. The first speaker was R. W. Mitchell, Ph.D., who spoke on cleaners.

R. Ligouri, vice-president, gave an interesting talk on "Practical Chromium Plating," in which he described in plater's language how he gets 100 per cent efficiency.

John Rolff, member of the New York Branch, read a paper on "Mechanical Barrel Plating," in which he showed that there is quite some technique to successful barrel plating.

Dr. L. C. Pan, instructor in Electroplating College of the City of New York, read a paper on "Throwing Power on Sulphate Zinc Solutions."

Dr. Pan, by his research work and through his tireless efforts, has benefited the plater considerably.

Another speaker whom we are always glad to have with us is Oliver Sizelove, who spoke on "Gilding Solutions."

World Building, Park Row, New York, March 13, 1931. The regular meeting of the New York Branch of the A. E. S. was held at the above place and date—President Haushalter presiding. No applications for membership received.

Communication from the Educational Bureau relating to educational matters for the future. As there was no further business, the chair was turned over to the Librarian, who stated that Mr. McStoker would say a few words. Mr. McStoker said it was a pleasure to have, as in many societies as well as our own, men who are good workers and leaders and where the members are appreciative of their work for the Society, and in their behalf presented a gold medal to President Haushalter.

Mr. Schor also made a speech, in which he praised the good work done by Secretary Sterling, and presented him also with a gold medal.

President Haushalter and Secretary Sterling thanked each and every member for their gift.

HARRY SIMON, *Recording Secretary.*

CHICAGO BRANCH

The regular monthly meeting of Chicago Branch, A. E. S., was held Saturday, March 14, 1931, at the Atlantic Hotel.

The meeting was called to order with President S. J. C. Trapp presiding and all officers present.

A very interesting paper on metal cleaning was read by Mr. J. Hay. Anyone having a cleaning problem (we all have them at times) should get a lot of good out of papers of this kind.

Members of Chicago Branch Please Notice

Beginning next meeting, Saturday, April 11, 1931, and continuing until the September meeting, between the hours of 7 and 8 p.m., a lecture will be given by Mr. Harold Faint.

All members should make a special effort to attend these lectures.

The business part of the meeting having been taken care of, the meeting was turned over to the librarian, Mr. O. E. Servis, and the following questions were found in the box:

Question—What is the best method to reduce excess iron in chrome sol.?

Answer—Chill sol. and filter through clean sand.

Question—How can 2S aluminum be nickel plated without using an acid dip, followed by a nickel or iron chloride dip? We want only one dip after the cleaner, before nickeling.

Answer—Use dip composed of nitric acid (specific gravity 1.42) 3 parts and hydrofluoric acid (50%) 1 part. Temp. 75 to 80 degrees F.

Question—Would like to know how to remove cyanide copper from a nickel sol.

Answer—Neutralize nickel sol. to pH 6.8 and then add .052 lb. lime per gal., allow to settle to a clear sol., remove precipitate, adjust pH to proper level.

Question—What is best sol. for chrome plating of dies, gauges, etc.?

Answer—This question was not definitely settled, because it was the opinion that only tools that were not under severe strain could be so treated.

Question—Wanted, a formula for oxidizing cadmium.

Answer—Dissolve about ¼ oz. platinic in hydrochloric acid and dilute to one gallon with water. Use cold.

Question—What is the best cleaner for die cast metal (zinc 90%, copper 5%, aluminum 5%)?

Answer—Any mild electro cleaner. Do not let temp. get above 175 degrees F. Use reverse current.

Question—Wanted, a formula for barrel lead plating.

Answer—It was suggested that the formula for fluoborate or fluosilicate sol. be tried.

FORMULA FOR FLUBORATE

Basic lead carbonate	20 oz.
Hydrofluoric acid (50%)	32 oz.
Boric acid	14 oz.
Glue	.025 oz.
Water	1 gal.

FORMULA FOR FLUOSILICATE

Lead fluosilicate	14 oz.
Hydrofluoric acid	12 oz.
Boric acid	2 oz.
Gum arabic	.25 oz.
Water	1 gal.

Temp. 80 to 100 degrees F. at 2 volts.

GE RE, WITH WORLD'S SHORTEST NAME, DIES

COLDWATER, Mich., March 18—The man said to have the shortest name of any person in the world, consisting of only four letters, was buried here today. Ge Re, dean of Coldwater merchants, died at the age of 90. He had been in business here fifty years.

Mr. Ge Re is the father of Andrew V. Re, one of our Grand Rapids, Mich., members who has contributed much to our Society. Our sincerest sympathy is extended to Andrew V. Re.

WATERBURY BRANCH

Friday, the 13th, was the day and date of the March meeting of Waterbury Branch. It proved successful in more ways than one. An excellent speaker and a good sized audience made an enjoyable combination.

The speaker was C. L. Mantell, Ph.D., consulting chemical engineer at Pratt Institute, who took for his subject "Competition for the Electroplating Industries." The remarks of the speaker were of an interesting nature, and served to bring out many points for discussion and comment. The lack of propaganda in the plating industry was freely commented on. New developments to compete against the plating industry were touched on. Attention was called to the class of platers who are giving the industry a black eye. The efforts of the Research Committee in its endeavors to arrive at satisfactory standards for the plating industry were favorably commented on. At the conclusion of his remarks the speaker answered many questions pertaining to the subject. President Wm. Gray extended the thanks of all present to the speaker for his interesting and instructive remarks. Favorable action was taken in the applications of Spencer L. Henn and Ralph H. Lee for associate membership. President Gray announced that a speaker had been secured for the next meeting, which takes place Friday, April 10. Refreshments will be served.

W. F. GUILFOILE, *Secretary.*

PHILADELPHIA BRANCH

Philadelphia Branch held its regular monthly meeting on March 6 at the Harrison Laboratory, University of Penna.

Report was read from Supreme President Gehling on the activities of the Education Bureau of the Supreme Society, and the members were pleased to hear that it is getting on the active list.

Mr. A. Munning read a paper on polishing wheels, and was given a rising vote of thanks for his splendid paper.

JOSEPH E. UNDERWOOD, *Secretary-Treasurer.*

APPLICATIONS

SAL PINTO, 1813 May Street, Los Angeles, California.....Los Angeles
MR. HENRY HAGEN, 11131 S. Clifton Park Ave., Chicago.....Chicago
MR. MICHAEL KENIRY, 2845 Madison St., Chicago.....Chicago
MICHAEL ARON (Assoc.).....Newark
FRANK BAULE (Active).....Newark Branch
H. C. SIMMONS, 219 S. Pryor St., S. W. Atlanta, Ga.....Philadelphia

ELECTIONS

THOMAS LYMAN, 18 Wadsworth Street, Malden, Mass.....Boston
MAC MUNNELL, 1188 Esperanza Street, Los Angeles, Cal.....Los Angeles
GEO. W. DEMPSEY, 830 W. 106th Street, Los Angeles, Cal.....Los Angeles
CARL SWARTY (Asso.), 51 S. Madison Ave., Allentown, Pa.....Philadelphia
THOS. WM. TURNER (Active), Storey Bros., Ltd., Queen St.,
Glebe, Australia.....Philadelphia

SUSPENSIONS

H. A. BRANNON, 8441½ S. Main Street, Los Angeles.....Los Angeles
H. VAN DALIAN, 1322 E. 12th Street, Los Angeles, Cal.....Los Angeles
F. T. DETRAY, 129 W. 66th Street, Los Angeles, Cal.....Los Angeles
C. D. MCTEVIA, 1117 Fremont Ave., Pasadena, Cal.....Los Angeles
N. SERVATIUS, Chicago Hdw. Foundry, North Chicago, Ill.....Milwaukee

DEATHS

R. W. KELLEY, 4449 W. Washington St., Chicago, Ill.....Chicago

TRANSFERS

L. A. DELAMOTHE.....From Los Angeles to San Francisco

HEAR YE! HEAR YE!

Lest Ye Forget!

YOUR PRESENCE REQUESTED
AT THE
COMING CONVENTION
OF THE

American Electro-Platers Society

TO BE HELD AT

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ROCHESTER, NEW YORK

"THE CONVENTION CITY"

June 29-30 — July 1-2, 1931

PAPERS: "Good" and "Plentiful."

EXHIBITS: We Solicit.

ENTERTAINMENT: We Aim to Please.

BRING THE LADIES
REMEMBER THE DATES

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Sec.-Treas., PHILIP SIEVERING,.....20 South Crescent, Maplewood, N. J.
S. E. HEDDEN, ...227 Fifth Ave., Aspinwall, Penn.
WILLIAM F. GUILFOILE, ...14 Oakland St., Waterbury, Conn.
DAN WITTIG,.....378 Third St., Milwaukee, Wis.
DR. WILLIAM BLUM,.....Bureau of Standards, Washington, D. C.
MR. OSCAR SERVIS,.....5305 Warner Ave., Chicago, Ill.
MR. N. E. ZADOWSKI,.....1383 W. 65th St., Cleveland, Ohio
MR. W. S. BARROWS, ...628 Dovercourt Road, Toronto, Canada
C. F. NIXON,.....Ternstedt Manufacturing Co., Detroit
DR. H. S. LUKENS,.....University of Pennsylvania, Philadelphia, Pa.

BUREAU OF EDUCATION

Chairman, MR. ALBERT HIRSCH,.....1945 Airdrie St., Philadelphia

Branch Representatives:

Chicago Branch.....HAROLD FAINT
Waterbury Branch.....ELLSWORTH CANDEE
Los Angeles Branch.....M. D. RYNKOFS
New York Branch.....HENRY LEVINE
Philadelphia Branch.....DR. A. K. GRAHAM
Baltimore-Washington Branch.....DR. WM. BLUM
Cleveland Branch.....J. C. SINGLER
Hartford-Connecticut Valley.....TENNANT ELWIN, FRANK J. CLARK
Worcester Branch.....M. H. FROMMANN
Toronto Branch.....C. KEMESH

Other Branch Representatives will be printed as received.

BALTIMORE-WASHINGTON

Meets in Enoch Pratt Library, Calhoun and Hollis Sts., Irvin H. Hahn, Secretary, 207 S. Sharp St., Baltimore, Maryland.

BOSTON

Meets at American House, Boston, Mass. First Thursday each month. Secretary A. W. Garrett, 45 King St., Dorchester, Mass.

BRIDGEPORT

Meets first and third Friday of each month at Chamber of Commerce Rooms, Stratfield Hotel. Secretary, T. H. Chamberlain, 969 Orange St., New Haven, Conn.

CHICAGO

Meets second Saturday of each month, at 8 p. m., Atlantic Hotel, 816 S. Clark St., Secretary, J. C. Kretschmer, 1914 Warner Ave.

CINCINNATI

Meets every Thursday, 7:30 p. m., at Vocational Training School, Spring and Liberty Sts. Secretary, Al Yeager, 2021 Sherman Ave., Norwood, Ohio.

CLEVELAND

Meets first Saturday of each month at Hotel Winton, Paul R. Stamm, Secretary, 947 Elbon Road, Cleveland Heights, Ohio.

DAYTON

Meets first Saturday of each month at the Y. M. C. A., Dayton, Ohio. Secretary, Robert G. Sumaa, 2734 Ridge Road, Dayton, Ohio.

DETROIT

Meets the first Friday of each month at the Hotel Statler, Louis II Room. Secretary, Chas. Phillips, 13421 Camden Ave., Detroit, Mich.

GRAND RAPIDS

Meets second Friday of each month at 826 Lake Michigan Drive, N. W. Secretary, Jacob Van Dyke, 1361 Union Ave., N. E., Grand Rapids, Mich.

HARTFORD-CONNECTICUT VALLEY

Meets fourth Monday in each month alternately at the Chamber of Commerce 315 Main St., Hartford and the Chamber of Commerce 134 Chestnut St., Springfield. Secretary Vernon Grant, 43 Putnam St., Bristol, Conn.

INDIANAPOLIS

Meets second Saturday of each month at Hotel Denison. Secretary, Louis Mertz, 1735 Union St., Indianapolis, Ind.

LOS ANGELES

Meets second Wednesday of each month at the Chamber of Commerce Bldg., 9th floor, 1151 S. Broadway. Secretary, M. D. Rynkofs, 1354 W. 35th St., Los Angeles, Calif.

MILWAUKEE

Meets second and fourth Thursdays of each month at Cor. 3rd and Highland Ave. J. M. Hock, 1239 W. 34th St., Milwaukee, Wis.

MONTREAL

Meets second and fourth Friday of each month at 1457 Aylmer St. Montreal, Quebec, Canada, where the Secy-Treas. Mr. Charles Doherty, can be found at any time.

NEWARK

Meets first and third Fridays of each month at Franklin Hall, 41 Franklin St., Newark, N. J., at 8 p. m. Secretary-Treasurer, Geo. Ruster, P. O. Box 201, Newark, N. J.

NEW YORK

Meets second and fourth Fridays of each month in the World Building, Park Row, New York City, N. Y. Secretary-Treasurer, J. E. Sterling, 2581 40th St., Astoria, L. I.

PHILADELPHIA

Meets first Friday of each month in the Harrison Laboratory Building, University of Pennsylvania, 34th and Spruce Sts. Secretary, J. E. Underwood, 327 N 19th St., Camden, N. J.

PITTSBURGH

Meets first Friday of each month at 8 p. m., at downtown branch, Y. M. C. A. Secretary, S. E. Hadden, 227 Fifth St., Aspinwall, Pa.

PROVIDENCE-ATTLEBORO

Meets first and third Thursday of each month at 44 Washington St., Prov. Engineers Rooms, Providence, R. I. Secretary, J. H. Andrews, 19 Rosedale St., Providence, R. I.

ROCHESTER

Meets third Friday of each month at Hotel Seneca. Secretary, Chas. Grillo, 24 Garson Ave., Rochester, N. Y.

ST. LOUIS

Meets second Friday of each month at the Plant of the Lasalco Co., 2328 LaSalle St. Secretary, C. T. McGinley, 3214 Fairbarn Ave., University City, Mo.

TOLEDO

Meets first Thursday of each month at Toledo Secor Hotel, Cherry and Page Sts. James M. Lee, Secretary, Barker Street, Fremont, Ohio.

TORONTO

Meets fourth Monday of each month at Canadian Foresters' Hall, 22 College St., Room No. 2. Secretary, H. W. Graham, 102 Robina Ave., Toronto, Canada.

WATERBURY

Meets second Friday of the month at Engineers Hall, No. 11 East Main Street. Wm. F. Guilfoile, secretary, P. O. Box 961, Waterbury, Conn.

WORCESTER

Meets Directors' Room, Chamber of Commerce, Worcester, Mass. Roger E. Bryant, Secretary, 94 Grove St., Worcester, Mass.